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(Continued from February number)

A paper was next presented by Mr. Forbes:

EXPERIMENTS WITH REPELLENTS AGAINST THE CORN ROOT-APHIS

By S. A. Forbes, *Urbana, Ill.*

(Abstract.)

In consequence of reports from farmers of beneficial results of the use of kerosene on seed-corn, a strip through a large field was planted, in 1905, with seed which had been soaked in kerosene, and as a result a considerable percentage of the seed was damaged, though the plants were protected for some weeks against injury by the corn root-aphis. On the supposition that the latter effect was due to the odor, experiments were made during the winter of 1905–06 with carbolic acid, oil of lemon, formalin, minimum quantities of kerosene, and a variety of other volatile oils and odoriferous substances, from which the four above mentioned were selected for trial in the field. The kerosene was used at the rate of a teaspoonful to a gallon of corn, thoroughly stirred in just before planting, the oil of lemon as a 10% solution in alcohol, and the carbolic acid and the formalin as 3% solutions in water. Three ounces each to a gallon of corn were used of the oil of lemon mixture and the carbolic acid solution, and six ounces to the gallon of the solution of formalin.

Strips of twelve to twenty-four rows each and eighty rods in length were planted with treated seed, intervening strips being left as

checks. The weather of the spring was dryer than usual, but not sufficiently so to delay noticeably the sprouting of the seed or the growth of the plants. A preliminary examination of the field showed an average of 512 colonies of *Lasius americanus* to each acre, equivalent to 1,840,000 adult and larval ants.

Six weeks after planting, hills were dug up freely in both check and experimental strips, and all the ants and aphids were counted in each case, with the general result that the strip planted with seed which had been treated with carbolic acid showed a reduction of 14% in number of aphids per hundred hills of corn, and 17% in number of ants; that treated with formalin showed a reduction of 60% in number of aphids and 48% in number of ants; the kerosene strip, a reduction of 84% in aphids and 58% in ants; and the strip planted with seed treated with the oil of lemon, a reduction of 89% in aphids and 79% in number of ants. The reduction in number of hills infested at this time was as follows: Carbolic acid, 15%; formalin, 44%; kerosene, 47%; oil of lemon, 58%. At the end of ten weeks the average height of stalks in the central row of a check strip—measuring only the highest stalk in a hill as it stood, without stretching it up—was 35 inches. The corresponding average of stalks in an experimental strip was 60 inches. On September 21, nineteen weeks after planting, a check row contained 330 hills with corn; a row from the oil of lemon strip, 326; a row from the kerosene strip, 282—a loss of 48 hills, due doubtless to the effect of the kerosene on the seed. The stalks at this time were 620 per row in the check, 641 in the plot treated with oil of lemon, and 510 in that treated with kerosene—a gain of 21 stalks, apparently due to the lemon treatment, and a loss of 110, due to the kerosene treatment. Ears at this time averaged 413 per hundred hills for the check strip, 526 to the hundred for the lemon strip, and 455 per hundred for the kerosene—a gain, from the use of lemon, of 113 ears and from the use of kerosene, of 42. The gain in number of ears was thus practically 20% where oil of lemon was used. There was also a notable difference in the size of the stalks and the ears in all the experimental strips as compared with the checks.

Similar and more extensive experiments made with a variety of more or less promising substances during the spring of 1907 were virtually without result, owing to heavy and repeated rains during the planting season and for some time subsequent, the effect of which was to remove all traces of the repellent substances from the planted seed and at the same time to suppress almost completely the corn root-aphis in the field. Trial plantings, made by farmers in various parts of the state, of seed-corn treated with oil of lemon, have in some cases re-

sulted in noticeable injury to the seed, showing that this substance as sold is of very unequal quality and apparently of unlike composition.

In reply to questions Mr. Forbes stated that the rows of corn in the field were about a quarter of a mile long; that the seed corn had been specially selected for the purpose and that, in the strips where the lemon oil was used, at a cost of about ten cents per acre, the ants were present between the rows, but very few aphids could be found.

Mr. Bishopp stated that he had tried repellants against the cotton boll weevil, including lemon, cinnamon, tar and clove oil. The odor of the latter was most persistent, but where it was used the plants showed greatest injury.

Mr. Forbes remarked that when lemon oil was introduced into artificial ants' nests it seemed to set them crazy, as they acted in a very confused and abnormal manner, even neglecting and deserting their young.

Mr. Taylor presented a paper:

LIFE HISTORY NOTES AND CONTROL OF THE GREEN PEACH APHIS, MYZUS PERSICAE

By E. P. Taylor, *Mountain Grove, Mo.*

The aim of this paper is to add a few new observations upon a very old insect. It was in 1761, nearly a century and a half ago, that Sulzer first described this pest in Europe. It has been mentioned in most works upon the Aphididæ as well as in treatises upon general entomology published in this country for many years, and has long since been included in the lists of insects injurious to the peach in the United States and Canada. Like many of our common insect enemies, however, there have been and are yet many points concerning it unrecorded.

During the past two years or more this insect has become in parts of the country a pest of more than passing importance. The peach growers of Western Colorado have suffered loss from it; from its heavy infestation of the leaves of the trees in the spring, causing them to curl and drop prematurely to the ground, and from the withering and subsequent dropping of the buds and forming peaches also infested by the aphides at this time. It is probable that in many parts of the country this plant louse has not yet appeared in such injurious numbers as to infest and destroy a portion of the crop itself as it has in Western Colorado, but the insect is of interest since it is known to

occur in nearly all portions of the United States where peaches are grown.

Our interest is also increased when we realize to what extent it has probably been confused with other species of the sub-family Aphididæ, and when we understand the factors which have led to this confusion.

My first notice of the insect as an economic pest in Colorado was at Grand Junction on April 13th, 1906, and brief mention was made of it in Bulletin No. 119, Colorado Agricultural Experiment Station. Its identity was then unknown to me and before undertaking any control experiments material was sent to Prof. C. P. Gillette, our best authority on the Aphididæ of that section. Samples of the material were also sent to Mr. Theo. Pergande of the United States Department of Agriculture, who gave to the insect the name *Rhopalosiphum dianthi* Schrank, as did Professor Gillette on first looking over the material. The latter, after further study of the insect and literature, concluded that the name *Myzus persicae* Sulzer should be applied to it. In this study of it certain matters of importance regarding the synonomy of the insect were brought out and I shall quote from a letter of Professor Gillette dated November 7th, 1907: "Let me change my opinion in regard to what this louse ought to be called. I decided to call it *diantha* Koch, but our species seems to be the *persicae* described by Sulzer in 1761 and which is described and figured by Buckton in his work on British Aphididæ, vol. 1, page 173. Buckton's figures correspond remarkably well with the louse that we have been working on here. I also believe that *Rhopalosiphum solani* Thomas, *R. dianthi* Schrank, and *Myzus achyrantes* Monell are synonyms of this species. All of the returned migrants that we have found upon plum, peach and cherry during the fall have had cornicles that were slightly swollen or clavate in form. The first winged forms in the spring that appear on these same trees seem exactly like the fall winged form, except that the cornicles are not at all swollen. I was greatly puzzled over this fact last spring and determined to watch very closely this fall to determine whether or not the form with swollen cornicles would again appear upon the peach and plum trees. For the past six weeks these migrants with swollen cornicles have been gathering upon these trees and depositing the oviparous form which becomes pink or salmon in color as it grows toward maturity. Since the middle of July we have been taking this louse upon a large variety of plants and in all cases we have found the cornicles swollen. This seems to account for the louse being called a *Rhopalosiphum* when described from the summer and fall form and *Myzus* when described from the early spring form before it leaves the peach, plum and cherry

tree. The specimens you sent April 30 and May 7 from peach all have cornicles cylindrical. The fall migrants and the specimens sent from tomato and turnips early in the summer all have clavate cornicles in the winged form. * * * The distinguishing character of this species for the winged individuals seem to be: Antenna longer than the body upon pronounced frontal tubercles which are quite approximate, second joint of antenna moderately gibbus, third joint with sensoria on the ventral side only and a large dark patch upon the dorsum of the abdomen anterior to the cornicles, and during the late part of the season the cornicle moderately clavate in the winged forms."

A point brought out by the foregoing is that the large per cent. of the descriptions of this and related species were made from specimens taken in the fall. I have recently had an opportunity to go over with Mr. J. T. Monell of St. Louis some accession records of collections of this species made during a period of about thirty years and the majority were found to have been made in the fall. In fact but a single exception to this was found, which was in the case of the species given by Mr. Pergande as *Aphis persicae* Sulz., and taken by him in St. Louis in May, 1879.

I have found in Western Colorado the eggs or stem-mothers of *Myzus persicae* Sulz. upon peach and plum and the lice have been found in that state at different times upon peach, nectarine, plum, prune, cherry, choke-cherry, sand-cherry and more rarely upon pear, apple, crab-apple, willow and cultivated rose. Also the following herbaceous plants have been found as host plants at some seasons of the year: Turnip, rape, cabbage, tomato, potato, false-mallow (*Malvastrum* sp.) yellow-dock, red-root (*Amarantus* sp.) mustard, shepherd's-purse, snap-dragon, carnation, rhubarb and egg-plant. In not every instance upon the plants given were the pink or salmon-colored lice present, although the collections were sometimes made in the spring or fall when this form would have been expected. This leaves perhaps a possibility of other species being mistaken for this one unless the kind of food plant had affected the coloration of the louse. Mr. Monell recently showed me two samples of what seemed to be this species taken by him November 2–4, 1907, at Shaw's Garden, St. Louis, one from cabbage and one from peach. Both cases showed the winged forms with slightly dilate cornicles and otherwise appearing the same, but none of the lice upon the cabbage showed the salmon color, though they were abundant upon the peach leaves at that time.

In this paper I have designated this insect as the green peach-aphis, to distinguish it from the black peach-aphis, with which it is sometimes confused. It is very different from the latter, however, which has in

the matured insects a shining black body and young of a reddish-brown. The latter, too, is known to sometimes infest the roots of the peach, while the green peach-aphis, so far as is known, occurs only above the ground.

If very abundant, the lice will be seen collecting thickly about the buds long before they open. If fewer in number, they may escape observation until the leaves are attacked and curled. In the spring of 1906 the writer noticed the serious bud infestation first on April 13. In 1907, eggs were found hatching at Grand Junction as early as February 16, owing to the unusually open winter and early spring. The eggs, small, oval and shining black, resemble very much the eggs of the green apple-aphis. They are deposited in the fall upon the twigs of peach or sometimes the plum or cherry and are tucked away under the bud or upon rough places along the bark, usually somewhere near the tips of the twig. They are not placed in such masses as the eggs of the green apple-aphis and it usually requires rather close searching to discover them. I found them deposited this fall as early as October 24 at St. Louis, and Professor Gillette reported them being laid freely at Ft. Collins, Colorado, as early as November 5.

Soon after hatching the lice crawl to some nearby leaf or fruit bud and insert their beaks into the more tender portion. At the time the first lice are hatched, the buds, though considerably swollen, are still protected by thick bud-scales which are more tender near the apex. The stem-mothers, when first hatched, are of a dark green color, with almost black appendages, and in length not more than 2-100 of an inch. As the inner and redder bud-scales are pushed out, these also become covered with stem-mothers, which after their first moulting of skins begin to assume shades of pink or salmon. These shades will be first noticed along the lateral margins of the body. As the stem-mother increases in size and continues to moult, this color becomes more prominent. Examined carefully, these dorsal abdominal markings will be found to consist of light terra-cotta or even maroon colors upon an apple green, the combination giving a salmon or pink in general effect. All stem-mothers do not take on this typical shade, but remain green throughout their lives and those which do assume the salmon color often fade back into almost a green toward the close of the period of their existence.

The stem-mothers blend very closely with the colors of the buds and blossoms and are therefore not easily seen. At the time of the birth of their first young, they measure about 8-100 of an inch in length. The young, which are born living, are at first much paler green in color than were the stem-mothers when first hatched. The apterous in-

dividuals of all generations appearing after the spring stem-mother remain greenish in color throughout the season up to when the sexual females are found upon the leaves in the fall. These deposit the over-wintering eggs and the lice are also of a salmon or pink shade, very much like the stem-mothers of the spring.

I have counted as many as a score of the stem-mothers in the spring clustered over the surface of a single unopen bud. When the buds break into bloom, these stem-mothers and their progeny crowd within, attacking petals and inner walls of the corolla as well as the stamens, style and ovary. The bloom is distorted, becomes withered and finally falls. In other cases the clusters of lice form later about the peaches, when about the size of peas, and by sucking away the sap cause them to also fall from the trees. About this time the lice will also begin to infest the leaves, curling them tightly, by infesting their under surfaces, and when severely attacked all parts of the leaf-blade will be completely covered. After the second molt of the stem-mothers, minute drops of honey-dew may be seen to form at the tip of the insects's body and be thrown away with a quick movement. This honey-dew may appear before the buds open as moist, sticky areas upon the twig above the louse. Later in the spring, the leaves in badly infested terminal clusters become completely coated with this secretion and attract numbers of ants, flies and other insects.

The infested leaves become thickened and pitted from beneath, turning red in spots and finally falling away. About the middle of May, 1907, many peach trees in Western Colorado were almost completely stripped of their foliage and it was feared by many growers that some would never revive.

Winged lice developed among individuals of the first generation following the spring stem-mothers and were seen in the orchards as early as April 13, 1907. They appeared as a rule first upon leaves greatly over-crowded by the wingless lice and soon after developing wings, spread to other leaves and trees to start new colonies. The proportion of winged ones increased as the season advanced. About the middle of May last year at Grand Junction, when the leaves of the trees had become heavily infested, not only winged but the wingless lice were seen to commence migration in great numbers from peach trees. By the last of May or the first days of June, scarcely a single one could be found upon them. It was indeed interesting to witness this phenomenal dispersion of plant lice. Each seemed anxious to forsake the peach leaves before its neighbor. Some days the air in badly infested peach orchards would be filled with flying aphides. The ground in such orchards would be thickly scattered with crawling,

wingless aphides. In one instance, trunk-bands of the sticky substance known as "Tree Tanglefoot" had been placed upon apple trees in order to catch the crawling woolly aphides. These apple trees were adjoining an orchard of peach and when the crawling lice from the peaches started up the trunks of the apple they were caught in such numbers that the lower borders of the bands were green with a mass of their bodies. The peach trees, now deserted by their parasites, the aphides, soon began to form new leaves and within a few weeks were once more in heavy foliage. The wingless migrating aphides evidently perished in great numbers upon the ground before reaching other food plants; some winged ones safely reached other plants at a distance, where they established new colonies and multiplied until the winged migrants returned again to the peach in the fall.

Life history records for the early spring generations were secured in the breeding cages. Stem-mothers were kept alive from twenty-three to twenty-nine days from hatching. About eight days passed from hatching to the first molt, four or five days from the first to the second molt and about the same time from the second to the third. From fifteen to seventeen days were passed by the stem-mother from hatching to the birth of the first young. This record was secured by confining single stem-mothers in cages alone, and thus demonstrating them to be parthenogenetic. The first young were born about the time of the third molting by the stem-mother. The maximum number of young secured from one stem-mother in the cages was twenty-six.

The first young of the second generation from the eggs were seen born in the orchard at Palisade on March 14, 1907, though some were secured in cages as early as March 4. From the birth of the second generation to the first molt was from four to five days and from their birth to their becoming equipped with wings was on an average of from eleven to sixteen days. This second generation usually bore the first of the third generation about twelve to seventeen days from their birth and at about the time the first winged lice appeared. Only a portion of the second generation of lice developed wings. From twenty-eight to thirty-three days seemed about the length of life from birth to death of a second generation individual.

The third generation of agamic aphides were found in the orchard at Grand Junction last season on March 24. These lice are a trifle smaller at birth than the generation born by the stem-mothers. It will be seen that as many as thirteen generations of the green peach aphis may be produced through a single season if the same rate of development is kept up through the summer to the time when eggs are again deposited in the fall.

The food plants which carry the species through its summer generation appear to be of great variety, as shown by the list already mentioned. So few lice are to be found, however, upon these plants during the summer in comparison with the countless numbers which are produced in the peach orchards in the spring that it seems very probable that other plants will also be found harboring it through the summer months.

In the Grand Valley peach orchards the first returning migrants were noticed about the middle of September, when I found them collecting upon the dorsal side of the leaves, principally along the midrib and veins, though they were not altogether restricted to these points. No early examinations of peach orchards were made in Missouri this fall, but on October 24, oviparous females were found depositing their eggs along the Mississippi and under date of November 5 Professor Gillette wrote me from Colorado that the eggs were being deposited upon peach, plum and cherry, though many of the winged and wingless viviparous females were still living upon many outdoor plants that had not entirely lost their foliage. The male insects are winged and appear in Colorado from about the middle of September to when they are killed by the cold nights. In Missouri, near St. Louis many eggs were still being freshly deposited in peach orchards as late as November 16.

Parasites and predaceous enemies rendered the orchardists of western Colorado much service in destroying great numbers of these insects last summer. Among these were the larvae of syrphus flies and lace-wings, and the larvae and adults of lady beetles. A small hymenopterous parasite was seen to infest the lice and a Thomisid spider identified by Mr. Banks as *Thisumena lepida* Thorell was observed to be of service. Sparrows, canaries, orioles and other birds were also of economic value.

Experiments by the writer towards the control of this pest were undertaken against it only so far as it affected the peach. In the commercial orchards of Western Colorado its only injury has been caused to this fruit.

The remarkable power peach trees have of reviving after being almost completely defoliated by these lice makes the insect somewhat less formidable. However trees so completely stripped of their foliage and devitalized as they are in some cases are retarded in both the development of the tree and fruit. From a practical standpoint the destruction of the lice which may infest the fruit buds, blossoms or newly formed peaches may be considered of the greatest consequence to the grower.

We find insecticides recommended against this insect in the works of Dr. Cyrus Thomas, formerly state entomologist of Illinois, and published in the transactions of the Illinois State Horticultural Society for 1876. Townsend observed the insect in New Mexico upon peaches and recommended contact sprays against it in Bulletin No. 3, New Mexico Agricultural Experiment Station, June, 1891. Saunders, Weed and many others have also suggested treatments. Washes of strong soap-suds, tobacco-water, kerosene emulsion and many other contact insecticides commonly used against sucking insects were advised.

From the experience of the writer, it has seemed that time and manner of application has had much to do with successful results. I have conducted experimental spraying against this insect near St. Louis, Missouri, in a peach orchard of about one hundred and thirty medium aged trees, the spraying being done on November 16. In Colorado a commercial peach orchard at Palisade was carefully selected and treated on March 16, 1907, when the stem-mothers were thickly covering the outside of the peach bud. The peach buds were swollen and ready to burst into bloom. The first new-born of the second generation were appearing, but neither these tiny green lice nor the larger pink-bodied stem-mothers had gained entrance into the blossoms beyond the reach of contact sprays. At that date practically all of the eggs had been hatched.

An orchard of about one hundred peach trees at Grand Junction was chosen in which no spraying was given up to April 16, when portions were given a thorough treatment with different contact sprays. At the time this spraying was done, the leaves of the trees were badly infested and the lice concealed to a large extent within the folds.

In both of the orchards a thorough spraying was given, but it was plainly apparent that the orchard first mentioned—the one sprayed late in the spring, but immediately preceding the opening of the buds—was the one in which the better results were secured. In the one sprayed after the leaves had become curled, it was found almost impossible to reach the bodies of the lice. Some of course were killed when a strong stream of spray was forced into the branches under a high pressure, but it was manifestly too late to expect the best results.

Among the most promising insecticides used in the experiments and by orchardists who sprayed last spring for this pest in Colorado were kerosene emulsion, containing 5% oil, Scalecide diluted 1 part to 20 parts cold water, tobacco decoction made by steeping for an hour 1 pound of leaf tobacco or 2 pounds strong tobacco dust or stems in

4 gallons of water. "The Black Leaf Extract of Tobacco" proved equally successful when used at the rate of 1 gallon to 65 gallons of cold water.

If the kerosene emulsion or other commercial oil emulsions are used, it should be with the usual precautions. Complete emulsification and known percentage of oil are essential. The above strengths of emulsion gave no injury used in the manner described. No practical benefit was secured, so far as the green peach aphis is concerned, from the use of orchard-boiled or commercial lime-sulphur washes, applied late in the spring just before the buds open. All spring prunings of the peach twigs should be gathered up and burned to prevent the aphis eggs harbored upon them from hatching and the lice crawling back upon the tree.

[Mr. Headlee's paper on *Diabrotica vittata*, together with the discussion thereupon, has been held till the next issue, owing to delay in submitting the manuscript.—E. P. F.]

The following paper was presented:

A KEY SUGGESTED FOR THE CLASSIFICATION OF ENTOMOLOGICAL RECORDS

By W. E. Hinds and F. C. Bishopp.

Object and application of key. This key is designed to facilitate the arrangement of entomological notes, materials, etc. It is not to be used as are guide cards, but all cards belonging in the key are *placed together in front of the note file* to show the general plan of arrangement of the notes which follow. Thus *one key* serves for the entire note system and no repetition is needed for the various species regarding which notes are made.

It is not at all necessary that all notes to be classified according to this key should be prepared in any particular form or kept together in one place. In fact, the key may be applied almost equally well to any notes except those in bound books. No argument is needed as to the many advantages of the modern card system over the old bound note book system. The size of cards to be used is a matter for personal choice and the only argument for uniformity is that of convenience in filing and handling the notes. In the Cotton Boll Weevil investigation a four by six inch card was found to be most convenient for field notes and therefore adopted for practically all records of the investigation. The cards were prepared by the printer in the

form of board covered books of fifty sheets each. The leaves were perforated to form the cards as they were removed from the binder.

Notes of any unusual size may be conveniently placed in the file by enclosing them in a manilla envelope of exactly the size of the standard card adopted. Envelope and note are headed alike to insure their identification. Old loose notes may be thus brought into the file with modern cards.

As a matter of convenience we have found it best to place the key on cards. On a card placed in front of the key proper should be given an alphabetical list of the ordinal names adopted or to be followed by the user of the note system. The notes on each order of insects then follow in the sequence indicated on the first card. Under each order the notes are arranged alphabetically by generic names and the species alphabetically under each genus. The notes on a single species are thus brought immediately together under the scientific name of the species. If the common name is more familiar, a cross reference can be made from an alphabetical list of common names. Thus far the arrangement is purely alphabetical, but beyond this point the necessity for some definite method of arrangement arises to enable anyone to find desired notes among a large amount of data and to make the file accessible to and usable by any other than the original maker or filer of the notes.

The key indicates the topical headings to be used and the arrangement to be followed in filing the notes on each and every species alike. It is no longer possible to follow an alphabetical plan and the decimal system used in the Dewey system of library cataloging and in the great work of the Concillium Bibliographicum has therefore been adopted in its principal features. Under each species name, the notes are filed strictly according to the decimal sequence of numbering, except in a few cases where subdivisions can be better arranged alphabetically. In the key a certain decimal number is given to each topic or subject heading, into which the study of the insect may be subdivided and this same subject and decimal number should always be given as the heading on the note to be filed. The statement of both number and subject prevents errors and the misplacement of notes.

Miscellaneous notes or those on undetermined species may be filed temporarily under their accessions number.

The first part of the key applies to general things which assist in systematizing one's work and related records.

Heading of notes. Every note or card should deal preferably with one subject only. The card is given appropriate heading and in de-

termining this the key is almost indispensable. The upper left-hand corner is always reserved for the decimal number associated with the proper subject. The scientific name of the species considered appears at the top and middle of the card. Below the species name is given the subject heading, locality, date, etc. The author's name should also appear on each note.

The decimal numbering may be conveniently done by a specially constructed rubber stamp made after the manner of the ordinary band dating stamps. This special stamp should have at least six bands, each bearing in vertical line the following fifteen characters as separated by dashes: 1—2—3—4—5—6—7—8—9—0—.—,—:—(—) Space cannot be taken here for a discussion of the proper use of the comma, colon and parentheses. It is the same as in the Dewey System.

The use of guide cards. In the key itself, guide cards are used for indicating only the primary divisions: Generalia, Work, Life History, etc. It is well to list on the guide card the next series of subdivisional headings occurring under it.

Among the notes to be filed, guide cards should, of course, be used for each species and headed with the names of the order, genus and species. Beyond this the use of guides is purely a matter of personal convenience and the filer may decide for himself whether he cares to give any special significance to the color of card, size of tabs, etc. The guides in no way alter or interfere with the application of the key.

Cross-references. If the subject matter on a card relates to more than one insect, a cross reference card is made and filed under the name of the other species, in the proper decimal sequence of the subject. Similarly, a cross reference is made if the record relates to more than one topic in the study of one species or if the data may have application to more than one topic.

Amplification of key. Throughout the key there is ample room for further development as may be required to adapt it more fully to the study of any new subject and insertions may be made as they are found to be needed. It will be noted that in the series of main divisional numbers, 8 and 9 are unoccupied. In these cases, as in similar ones throughout the key, wherever numbers have been omitted or are unoccupied, there is room for additional subjects of properly coordinated character. Changes may be made to suit the user, either in the wording or character of a subject heading to fit any special need, but if there be room for addition of the needed subjects, it would seem better to add than to substitute. In this way the key is rendered more complete and generally applicable. Inappropriate head-

ings are simply unused, but remain in the key for the suggestive value they have and for use under species to which they do apply.

Practical usefulness of key. A fairly complete outline of this sort is valuable for its continual suggestion when undertaking the thorough study of any species. With any large volume of notes, particularly relating to one species, some system is indispensable. The key given herewith has been put to thorough test in the large amount of note material accumulated by the numerous agents of the Bureau of Entomology during the six years of the Cotton Boll Weevil investigation. Because of its proven value in this work, it is presented here as a suggestion of the possible divisions in the study of an economic entomological subject and as a practicable means of so arranging the records as to make them at all times easily accessible and completely useful and also because the system seems to be of general applicability in economic entomology.

Key to Classification of Entomological Records

O Generalia.

01 Bibliography.

- 01.1 Indices and references.
- 01.2 Special literature.
- 01.3 State laws affecting entomology.
  - 01.31 Quarantine regulations.
  - 01.32 Inspection of nursery stock.
- 01.8 Literature to secure.
- 01.9 Miscellaneous literature.

02 Statistical data.

- 02.1 Climatological. (See 44 also.)
- 02.2 Geological.
- 02.3 Crop reports.
- 02.4 Special census reports.
- 02.5 Special crop statistics.

03 Clippings.

- 03.1 Entomological workers.
- 03.2 Insect life histories. (See 71 for arrangement.)
- 03.3 Insect seasonal histories. (See 71 for arrangement.)
- 03.4 Insect control, natural.
  - 03.41 Climatological.
  - 03.42 Parasites.
  - 03.43 Predatory enemies.
  - 03.44 Diseases.
- 03.5 Insect control, artificial.
  - 03.51 Traps.
  - 03.52 Insecticides.
    - 03.521. Stomach poisons. (Arrange alphabetically.)
    - 03.522 Contact insecticides.
    - 03.523 Fumigants.
  - 03.53 Repellents.

O Generalia, *Continued*.

03 Clippings.

  - 03.54 Machines.
  - 03.55 Treatment of crop after harvesting.
  - 03.56 Restriction of spread.
  - 03.57 Cultural control.
- 03.6 Distribution.
  - 03.61 Geographical.
  - 03.62 Geological.

04 Accounts.

- 04.1 Appropriations.
- 04.2 Salaries.
- 04.3 Equipment.
  - 04.31 Furniture and fixtures.
  - 04.32 Scientific apparatus.
  - 04.33 Tools and machinery.
  - 04.34 Library.
  - 04.35 Live stock.
- 04.4 Maintenance.
  - 04.41 Supplies.
  - 04.42 Repairs.
- 04.5 Postage, stationery, etc.
  - 04.51 Postage account.
  - 04.52 Stationery accounts.
  - 04.53 Telegraph accounts.
  - 04.54 Telephone accounts.
- 04.6 Travel.
- 04.7 Freight and express.
- 04.9 Contingent expenses.

05 Species lists.

- 05.1 Economic insects.
- 05.2 Insects reported during correspondence.

O Generalia, *Continued.*

06 Host lists.
- 06.1 Animal hosts.
- 06.2 Plant hosts.

07 Documents.

08 Correspondence.
- 08.1 Special mailing lists.

09 Miscellaneous.
- 09.1 Inventory.
- 09.2 Common name directory of insects.

1 Work.

10 Work projected.
- 10.1 Outlines prepared for projects.
- 10.2 Forms for tabular records.

11 Work on hand.

12 Questions.

13 Instructions.
- 13.1 Forms for uniform note records.

14 Reports of species, occurrence to be investigated.

15 Methods and apparatus.

18 Illustrations.
- 18.1 Photography.
  - 18.11 Formulae, tables and method notes.
  - 18.12 Negative catalog. (Arrange alphabetically by subject, referring to consecutive numbers assigned to negatives.)
- 18.2 Drawings.
  - 18.21 Record of sketches.
- 18.3 Cuts.
  - 18.31 Catalog of cuts. (Arrange alphabetically by subject, referring to consecutive numbers assigned to cuts and to where cuts have been used.)

19 Reports of completed work.
- 19.1 Periodical reports of agents.
- 19.2 Publications listed.

2 Life History.

21 Egg.
- 21.1 Description.
- 21.2 Embryology.
- 21.5 Duration of stage.
- 21.6 Hatching.

22 Larva.
- 22.1 Description.
- 22.2 Anatomy.
  - 22.21 External.
  - 22.22 Internal.

2 Life History, *Continued.*

22 Larva.
- 22.3 Growth.
- 22.4 Molts.
  - 22.41 Process of molting.
  - 22.42 Effect of food supply upon number of molts.
  - 22.43 Size between molts.
- 22.5 Duration of stage.
- 22.6 Pupation.
  - 22.61 Pupal cells.

23 Pupa.
- 23.1 Description.
- 23.2 Anatomy.
- 23.5 Duration of stage.
- 23.6 Transformation.

24 Adult.
- 24.1 Description.
- 24.2 Period from transformation to emergence.
  - 24.21 Changes before emergence.
- 24.3 Emergence.
  - 24.31 Changes after emergence.
- 24.4 Size of adults.
  - 24.41 Dimensions.
  - 24.42 Weights.
  - 24.43 Relation of size to food supply.
- 24.5 Duration of life.
  - 24.51 Upon buds alone.
  - 24.52 Upon seed pods alone.
  - 24.53 Upon foliage alone.
  - 24.54 Upon sweetened water.
  - 24.55 Without food but with water.
  - 24.56 Without food or water.
  - 24.57 Average length of life, natural condition.
  - 24.58 Hibernated adults without food.
- 24.6 Sexes.
  - 24.61 Secondary sexual characters.
  - 24.62 Relation of size and color to sex.
  - 24.63 Proportion of sexes.
    - 24.631 In spring.
    - 24.632 In mid-summer.
    - 24.633 In autumn.
    - 24.634 During hibernation.
    - 24.635. Among migrating adults.
  - 24.64 Temperature influence upon sex determination.
- 24.7 External anatomy.
- 24.8 Internal anatomy.
- 24.9 Physiology.

25 Development.
- 25.1 Number of generations. (Localities arranged alphabetically by state and town.)
  - 25.11 Minimum number in season.

2 Life History, *Continued.*

25 Development.

25.12 Maximum number in season.
25.13 Average number in season.
25.2 Temperature influences. (See 31.12, 31.42 and 44.)
25.21 On activity of adults.
25.22 On rapidity of development.
25.221 During winter.
25.222 During summer.
25.223 Proportion of stages at different periods.
25.23 On sex determination.
25.24 Effective temperature studies.
25.3 Proportion of infested fruit producing adults.
25.5 Duration of life cycle. (Localities arranged alphabetically by state and town.)
25.51 Maximum duration.
25.52 Minimum duration.
25.53 Average duration.

26 Habits.

26.1 Food plants. (List by Order, Family, Genus and Species.)
26.11 Portion of plant attacked, and effects.
26.111 Leaf buds.
26.112 Fruit buds.
26.113 Foliage, including petioles.
26.114 Flowers.
26.115 Fruit.
26.116 Seed.
26.117 Stem. (Trunk and branches.)
26.118 Bark.
26.119 Root.
26.12 Tests of other plants for food.
26.13 Susceptibility of different varieties of food plants.
26.19 Occurrence on other than food plants.
26.2 Hosts.
26.3 Prey.
26.4 Feeding habits.
26.41 Larval.
26.42 Adult, male.
26.43 Adult, female.
26.44 Both sexes together.
26.45 Feeding on certain plant species.
26.451 Temperature influence on feeding activity. (See 25.2.)
26.452 Feeding activity in different parts of the day.
26.453 Location of food supply by adults.
26.46 Destructive power by feeding.
26.47 Cannibalism. (See 43.)

2 Life History, *Continued.*

26 Habits.

26.48 Predaceous habits.
26.481 Among larvæ.
26.482 Among adults.
26.49 Movement on food plant.
26.491 During day.
26.492 During night.
26.5 Trap foods. (See 51.1 and 51.2.)
26.6 Adaptive capacity.
26.61 To variations in food supply.
26.62 To variations in climatological conditions.

27 Reproduction.

27.1 Copulation.
27.11 Age at beginning.
27.12 Attraction between sexes.
27.13 In spring before feeding.
27.14 Duration of copulation.
26.15 Polygamy.
26.16 Polyandry.
27.2 Fertility.
27.21 From a single copulation.
27.22 Parthenogenesis.
24.23 Fertility of hibernated individuals.
27.24 Duration of fertility.
27.3 Oviposition.
27.31 Age at beginning.
27.32 Period between copulation and oviposition.
27.33 Portion of plant chosen for oviposition.
27.331 Leaf buds.
27.332 Fruit buds.
27.333 Foliage, including petiole.
27.334 Flowers.
27.335 Fruit.
27.336 Seed.
27.337 Stem, including trunk and branches.
27.338 Bark.
27.339 Root.
27.34 Miscellaneous places for oviposition.
27.35 The act of oviposition.
27.351 Preliminary examination.
27.352 Formation of cavity.
27.353 Deposition of egg.
27.354 Sealing of cavity.
27.355 Time required to deposit an egg.
27.356 Position of female while ovipositing.
27.357 Activity in ovipositing during different parts of day.
27.358 Stimulation to oviposition by abundance of food supply.

2 Life History, *Continued.*

27 Reproduction.

27.359 Number of eggs deposited.
27.36 Selection of uninfested places for oviposition.
27.37 Dependence of oviposition upon food supply. (See 32.7.)
27.4 Effects of oviposition.
27.41 In various portion of plant species.
27.411 (List as under 26.11.)
27.5 Period of oviposition.
27.51 In hibernated individuals.
27.52 In first generation individuals.
27.53 In individuals of other generations.
27.54 First oviposition in season.
27.55 Last oviposition in season.
27.6 Rate of oviposition.
27.61 Daily rate in laboratory.
27.62 Daily rate in field.

28 Protection.

28.1 Egg.
28.11 When deposited internally.
28.12 When deposited externally.
28.13 By isolation.
28.14 By external structure.
28.15 By protective excretions.
28.2 Larva.
28.21 By place of development.
28.22 By external structure.
28.23 By protective devices.
28.231 By repellent odors.
28.232 By protective constructions.
28.233 By protective excretions.
28.24 By habits.
28.241 Concealment.
28.242 Feigning death.
28.243 Feeding internally.
28.25 By fighting ability.
28.26 By locomotion.
28.261 By flight.
28.262 By running.
28.263 By swimming.
28.29 By coloration.
28.291 Mimicry.
28.292 Warning coloration
28.3 Pupa.
28.31 By place of pupation.
28.32 By molted skins.
28.33 By protective constructions
28.331 Cocoons.
28.332 Earthen cells.
28.333 Leaf rolling.
28.334 Gall formation.
28.39 By coloration.
28.4 Adult.
28.41 By place of transformation.

2 Life History, *Continued.*

28 Protection.

28.42 By external structure.
28.43 By protective devices.
28.431 Repellent odors.
28.432 Protective constructions.
28.433 Protective excretions.
28.44 By habits.
28.441 Concealment.
28.442 Feigning death.
28.443 Feeding internally.
28.49 By coloration.
28.491 Mimicry.
28.492 Warning coloration.

29 Multiplication.

29.1 Annual progeny of one pair. (Theoretical.)
29.2 Number of individuals per acre based upon field counts.
29.3 Relation of multiplication to food supply.
29.4 Restrictions upon multiplication. (See 4 and 5.)

3 Seasonal History.

31 Hibernation.

31.1 Entrance into hibernation.
31.11 Time of entrance.
31.12 Temperatures affecting entrance. (See 25.2.)
31.13 Gradual entrance.
31.14 Stages entering hibernation.
31.15 Congregation of individuals preceding entrance into hibernation.
31.16 Mortality occurring at time of entrance into hibernation.
31.17 Activity during hibernation period.
31.2 Shelter during hibernation.
31.21 Apparently favorable conditions.
31.22 Apparently unfavorable conditions.
31.3 Mortality during hibernation.
31.4 Emergence from hibernation.
31.41 Time of emergence.
31.42 Climatic conditions affecting emergence.
31.43 Re-hibernation.
31.44 Number and percentages surviving hibernation.
31.5 Duration of hibernation.
31.51 Localities of observations arranged alphabetically by state and town.

32 Hibernated individuals.

32.1 Finding food supply in spring.
32.11 Distance hibernated individuals will go to food.

3 Seasonal History, *Continued.*

30 Hibernated individuals.

32.2 Nature of first food supply.
32.3 Preferred food supply.
32.5 Duration of life of hibernated individuals.
32.6 Movement of hibernated individuals in field before beginning reproduction.
32.7 Oviposition dependent upon food. (See 27.37.)
32.8 Abundance of hibernated individuals.

33 Progress of infestation.

33.1 Species injury *versus* food production.
33.2 Effect of maximum infestation upon species multiplication.
33.3 Proportion of food supply attacked not destroyed.
33.4 Relation of species to crop production.
33.41 Special crop.
33.411 Percentage of crop destroyed.

34 Dispersion, spread of species. (See 63.)

4 Natural Control.

41 Mechanical control.

41.1 Resistance to attack of species by normal special plant structures.
41.11 Pilosity of stems.
41.12 Appression of floral envelopes.
41.2 Resistance to species attack by abnormal plant growths.
41.21 By gall formation.
41.22 By proliferation in buds.
41.23 By proliferation in seed pods.
41.24 By proliferation in stem.
41.25 By proliferation in root.
41.26 Influence of locality on proliferation.
41.27 Influence of season on proliferation.
41.28 Influence of variety on proliferation.
41.29 Influence of artificial conditions upon proliferation.
41.291 Cultivation.
41.292 Fertilization.
41.4 Artificial stimulation to proliferation.
41.41 In buds.
41.42 In seed pods.
41.5 Mortality in species due to proliferation.
41.51 In buds.
41.52 In seed pods.

4 Natural Control, *Continued.*

41 Mechanical control.

41.6 Manner in which death is caused by proliferation.
41.7 Rearing stages on prolifid cells as food.
41.8 Proliferation started from other causes than species attack. (Arrange alphabetically.)
41.9 Occurrence of proliferation in other plants than special species. (Arrange alphabetically by order, etc.)

42 Restraint upon species attack by habits of growth of food plant.

42.1 Rapid maturing of fruit.

43 Cannibalism. (See 26.47.)

43.1 Among adults.
43.2 Among larvæ.

44 By climatological conditions. (See 02.1.)

44.1 Heat or drying.
44.11 Mortality in picked fresh fruit.
44.111 Buds.
44.112 Flowers.
44.113 Seed pods.
44.12 Mortality in dried hanging fruit.
44.121 Buds.
44.122 Flowers.
44.123 Seed pods.
44.13 Mortality in fallen fruit.
44.131 Buds.
44.132 Flowers.
44.133 Seed pods.
44.14 Heat effect upon adults.
44.141 On hot ground.
44.2 Cold.
44.21 Effects of frosts.
44.211 Upon food supply.
44.212 Upon life of adults.
44.213 Upon life of immature stages.
44.22 Effect of minimum winter temperatures.
44.221 Upon life of adults.
44.222 Upon life of immature stages.
44.25 Experiments in artificial refrigeration.
44.3 Humidity.
44.31 Drought.
44.32 Excessive humidity.
44.4 Precipitation.
44.41 Precipitation deficient.
44.42 Precipitation excessive.

4 Natural Control, *Continued.*

44 By climatological conditions.

44.5 Overflows.
- 44.51 In summer.
- 44.52 In winter.
- 44.55 Experiments in drowning adults, floating.
- 44.56 Experiments in drowning adults, submerged.
- 44.57 Experiments in drowning immature stages.
- 44.58 Experiments in submerging eggs.

45 Diseases of species.

45.1 Fungus diseases.
45.2 Bacterial diseases.

46 Parasites.

46.1 Breeding of parasite species.
- 46.11 Species list of primary parasites.
  - 46.111 Parasites of egg.
  - 46.112 Parasites of larva.
  - 46.113 Parasites of pupa.
  - 46.114 Parasites of adult.

46.2 Mortality due to parasites.
- 46.21 In egg stage.
- 46.22 In larval stage.
- 46.23 In pupal stage.
- 46.24 In adult stage.
  (Arrange data by locality and date.)

46.3 Transference of parasites of other insects to species.

46.4 Hyperparasitism.
- 46.41 Species list.

46.5 Increasing efficiency of parasites.
- 46.51 Importation of parasites.
  - 46.511 Transference of parasites from one locality to another.
  - 46.512 Introduction of foreign parasites.
- 46.52 Artificial propagation and distribution.
  - 46.521 On preferred host.
  - 46.522 By securing concentration on desired host by practices affecting multiplication on alternate hosts.

47 Predatory enemies.

47.1 Insecta. (Arrange by order, genus, and species alphabetically, as suggested in explanation of key.)
47.2 Arachnida. (Arrange as above.)
47.3 Crustacea. (Arrange as above.)
47.4 Pisces. (Arrange as above.)
47.5 Reptilia. (Arrange as above.)

4 Natural Control, *Continued.*

47 Predatory enemies.

47.6 Aves. (Arrange as above.)
- 47.61 Examinations of bird stomachs.

47.7 Mammals. (Arrange as above.)

5 Artificial Control.

51 Traps.

51.1 Trap foods, unpoisoned.
- 51.11 Sweets.

51.2 Trap foods, poisoned.
51.3 Trap lights.
51.4 Trap shelters.
51.5 Trap rows.

52 Insecticides.

52.1 Stomach poisons. (Arrange alphabetically.) (See 59.41 also.)
52.2 Contact insecticides. (Arrange alphabetically.)
52.3 Fumigants. (Arrange alphabetically.)
52.9 Other insecticides tested. (Arrange alphabetically.)

53 Repellents. (Arrange alphabetically.)

54 Farm machinery.

54.1 Special machines for the destruction of pest.
54.2 Attachments to machinery commonly used in cultivation of crop.
54.3 Machines for aiding in destruction of food supply.
54.4 Improved machines advisable for general farm use.

55 Treatment of crop after harvesting.

55.1 Temporary storage.
- 55.11 Cold storage.
- 55.12 Elevators.
- 55.13 Cellar storage.

55.2 Mechanical treatment of crop.

56 Restriction of spread.

56.1 Quarantines.
- 56.11 Regulations of various states. (Arrange alphabetically.)

56.2 Legislative enactments desirable.
56.3 Restricting of movement of crop within border of infestation.
56.4 Disinfection of shipments to points beyond border of infestation.
- 56.41 Treatment of crop shipped.
- 56.42 Treatment of cars used.

5 Artificial Control, *Continued.*

56 Restriction of spread.

56.7 Restriction of multiplication of species.
56.71 Hand picking.
56.711 Of insects themselves.
56.712 Of infested fruit.
56.72 Burial by cultivation.
56.721 Of insects themselves.
56.722 Of infested fallen fruit. (See 57.5.)
56.73 Trapping hibernated individuals. (See 51.)
56.74 Destruction of favorable hibernation quarters.
56.75 Proper spacing of rows and plants.
56.76 Fall destruction of food supply. (See 54.3 and 57.7.)
56.77 Rotation of crops. (See 57.9.)

57 Cultural methods of control.

57.1 Selection of best seed.
57.2 Thorough preparation of soil.
57.3 Fertilization.
57.4 Early planting or uniform planting.
57.5 Thorough cultivation.
57.6 Early harvesting.
57.7 Early destruction of annual plants.
57.8 Fall breaking of land.
57.9 Rotation of crops.

59 Experimental farm work.

59.1 Data regarding locations.
59.11 Alphabetical list of localities arranged by years.
59.12 Alphabetical list of names and addresses of owners and operators of farms.
59.13 Geological conditions represented by farms.
59.14 Climatological conditions represented by farms.
59.15 Proposals for experimental work.
59.16 Contracts for experimental work.
59.2 Data regarding experiments with crops.
59.21 Early planting tests.
59.22 Late planting tests.
59.23 Variety tests.
59.24 Fertilizer tests.
59.25 Cultivation tests.
59.26 Soil tests.
59.27 Isolation tests.

5 Artifical Control, *Continued.*

59 Experimental farm work.

59.3 Data regarding insect conditions. (Arrange by locality alphabetically and chronologically.)
59.4 Data regarding remedial experiments.
59.41 Paris green experiments.
59.411 Applied as dust.
59.412 Applied as spray.
59.45 Cultural remedial experiments.
59.5 Data regarding cultural conditions.
59.51 Preparation of soil.
59.52 Fertilization given.
59.53 Time of planting.
59.54 Cultivation given.
59.55 Destruction of plants.
59.56 Fall treatment of soil.
59.6 Data regarding crop conditions.
59.61 Germination.
59.62 Growth before flowering.
59.63 Flowering.
59.64 Setting of fruit.
59.65 Harvesting.
59.66 Yield.
59.67 Foliage area.
59.68 Number of plants per acre.
59.7 Data regarding climatological conditions.
59.8 Methods commonly used by most successful farmers.
59.81 For special crop. (List by name and address.)
59.9 Data regarding results.

6 Distribution of Species.

61 Geographical distribution.

61.1 Alphabetical list of recorded localities arranged by the state, county and town.
61.2 Maps showing distribution.

62 Status of species.

62.1 Inspection reports.
62.11 Species found present.
62.12 Species not found.
62.2 Special studies of areas of especial abundance of species.
62.3 Special studies of areas of especial scarcity of species.

63 Dispersion (spread) of species.

63.1 By natural agencies.
63.11 By flight.
63.111 In spring, seeking food.
63.112 In midsummer.
63.113 In fall.

6 Distribution of Species, *Continued.*

63 Dispersion (spread) of species.

63.114 When going into hibernation.
63.115 Seasonal influence upon taking flight.
63.12 By crawling.
63.13 By winds and storms.
63.14 By water along waterways.
63.15 By floods and overflows.
63.16 By artificial carriers, not hosts.
63.17 By movement of hosts as carriers.
63.2 By artificial agencies.
63.21 By shipments of infested materials.
63.22 By movement of containers which have carried infested materials.
63.221 Cars.
63.222 Barrels and other containers.
63.223 Harvesting apparatus.
63.23 By movement of carriers only accidentally related to pest.
63.231 Vehicles passing infested fields or near plants.

7 Collection.

71 Classification. (Orders alphabetically.)
72. Accessions catalog.
73 Species catalog.
74 Description list, new species described.
75 Type list and disposition of types.

In discussing the paper Mr. Hunter stated that the system described was a modification of the one used by Mr. Quaintance and was especially valuable in cases where a large amount of data on an insect must be kept so that it can be available for easy reference.

Mr. Felt preferred to use a method that was simpler than the Dewey system, as it took considerable time to train assistants so they could use it to advantage. By means of the system in his office it was impossible to lose any of the note sheets.

Mr. Hart stated that there is little danger of losing sheets or cards. The system in use in Dr. Forbes' office is essentially somewhat similar but not numerical. The great advantage of the system described by Mr. Bishopp is in keeping before the eye the points which should be investigated.

Mr. J. L. Phillips considers the Dewey system a valuable one for arranging correspondence for easy reference. He uses a modification of this system, arranging the counties alphabetically, as well as giving each county and correspondent a number and using decimals to make further sub-divisions for each county. This method is specially valuable where it is necessary to keep in touch with a large number of county inspectors and persons in the inspectors' territory who write about this line of work. Under such a system it is easy to refer at once to the correspondence on this subject with people in any county without going to the card index. All this correspondence can be taken out of the files, examined and returned in a few minutes, while under other systems it would be necessary to keep a cross index, and the cor-

respondence with any one person would be kept in a separate folder. The method outlined above does not require any extra work and very much less time is needed to refer to the correspondence from any one county. This method presupposes, of course, that carbon copies of letters are filed instead of using the letter book system.

Owing to the lateness of the hour, the meeting adjourned until 9.30 a. m. Saturday, with the understanding that the two papers remaining on the program be read first.

Morning Session, Saturday, December 28, 1907

Arrangements had been made for a joint meeting of this association and the Association of Horticultural Inspectors and the program had been arranged accordingly. The session was called to order at 9.30 a. m. by President Morgan, and the following paper was presented:

BEE DISEASES: A PROBLEM IN ECONOMIC ENTOMOLOGY

By E. F. Phillips, *Washington, D. C.*

Bee keeping in the United States is a sole means of livelihood to a comparatively small number of persons, but taken as a whole it forms an industry which commands recognition. Every year the manufacturers of supplies in this country make from 60,000,000 to 75,000,000 sections for comb honey and practically all of these are used in the United States. A study of market conditions will reveal the fact that there is three or four times as much extracted honey as comb put on the market, mainly because of the heavy demand for confectionery and baking purposes. A species of insect which forms the basis for an industry adding from $20,000,000 to $25,000,000 to the resources of the country annually is well worthy of consideration in economic entomology.

No one conversant with bee keeping conditions would claim that the entire field is now occupied. It is safe to say that many times as much nectar goes to waste and dries up annually as is gathered by honey bees; probably this country could produce ten times the present yearly honey crop were there more and better bee keepers properly located. In attempting to aid in the building up of this industry, it is necessary to determine the causes which prevent its rapid growth. The two principal causes seem to be too general an ignorance of modern methods of manipulation, and the brood diseases of the bees. The education of all bee keepers to proper methods is no small un-

dertaking, but the other impediment will effectually prevent advancement unless handled vigorously.

There are now recognized two diseases of the brood which are infectious in their character: These are designated American foul brood and European foul brood. While they differ in their cause and symptoms, their ultimate effect is similar. The brood succumbs to the disease and the colony dwindles from a lack of young bees to replace the old workers, which die of old age. Finally the colony is entirely destroyed. It is now definitely determined that American foul brood is caused by a specific micro-organism, *Bacillus larvae,* and probably European foul brood is caused by some other micro-organism, since it is equally infectious and spreads in the same manner.

When a colony dies from disease, bees from another colony rob the hive and thus carry infection to their own hive. Disease may also be spread by feeding a colony honey which has been extracted from a hive containing disease and by introducing queens which come in cages containing candy made with infected honey.

The investigation of the causes of these diseases has attracted the attention of scientists for many years. In Europe, at present, there are several bacteriologists at work on the subject and it is also one of the lines of work now being pursued in the agricultural investigations of the Bureau of Entomology. The work so far done indicates that the problem is by no means an easy one and that it should be investigated by well trained men. The work has, in fact, suffered from the publications and statements of untrained men, and it is to be hoped that in the future it will not be necessary to spend more time pointing out the mistakes in immature work.

The control of these two diseases is the great economic problem now confronting those interested in this industry. The present approved method of treatment for both diseases consists of the removing of all infected material from the colony and in compelling the bees to build new, clean combs. Perhaps, when the characteristics of the causal micro-organisms are better known, it may be possible to devise methods for the use of disinfectants or drugs to save the comb, but until more information is available, the use of drugs, either for feeding or for fumigation, cannot be advised. Several attempts have been made to save the combs by fumigation with formalin, but this is only experimenting in the dark, and it is safe to recommend only such methods as are known to be effective.

While it is possible for any bee keeper to eradicate either disease from his apiary, it is difficult to get all bee keepers to do it; and care-

less or ignorant persons, who do not treat the disease, harbor a menace to all the bee keepers in the neighborhood. For this reason, inspection of apiaries for disease has been instituted in several states. As in the case of all inspection, the work of these men is not only that of a police officer empowered to enforce the law, but it is also largely educational. Good results have come from this supervision in almost all cases, and they follow whenever a thorough man is in charge of the work. In several states not now having inspection of apiaries, the bee keepers are asking for its institution; and it seems probable that before long this phase of the work will be well under way whenever either disease is severe.

The present weak point in state inspection seems to the writer to be a lack of the proper kind of supervision of the inspection. The inspectors are usually good practical bee keepers and are experts in the detection and treatment of disease. As a rule, however, they know little of the methods used in other lines of inspection and are equally uninformed on all other phases of entomological work which would be valuable for purposes of comparison. It would seem desirable, therefore, that apiarian inspection be under the supervision of the state entomologist; not that the entomologist himself should do the work, for he has enough to do, but that the inspector should be responsible to him. In fact, in most cases, a practical bee keeper would be better able to handle disease than the entomologist who may not be trained in the practical manipulation of bees, which is an absolute essential to effective work. In Texas the state entomologist is also foul brood inspector, but has four assistants who do the actual inspection.

I would not have any of the previous statements interpreted as reflecting adversely on the present inspectors; their work commands the highest respect, with but few exceptions. The official entomologists may feel that such a recommendation tends to impose additional arduous duties on men already overworked, but apiculture is a branch of economic entomology, and the honey bee, as a most beneficial insect, demands attention. The only reason for suggesting this supervision by the state entomologist is the belief that an entomologist is better able to direct in this work than any other state official. If the entomologist is also a trained bee keeper, the efficiency of the work would be inestimably increased.

Even if the state law does not specify that the entomologist shall have supervision of this inspection, he may be of the greatest value, not only in the eradication of bee disease, but in the furtherance of the bee-keeping industry, by giving out information concerning im-

proved manipulations and by getting bee keepers in touch with persons who can give them information which may be desired. This need is felt in the apicultural work of the Bureau of Entomology. To spread information concerning new results obtained in our own investigations, or those of others, it is very desirable that there be some person nearer to the bee keeper who can give out the information. At present, in the majority of cases, our only means of reaching the persons whom we aim to assist is by direct communication or through the bee journals. If the official entomologists took more interest in apicultural work, we feel that it would bring new work nearer to the honey producer, even if no new investigation were undertaken by the entomologist himself. For this reason, it is earnestly desired that in the insect work in each state, apiculture may have a part.

As far as the apicultural work of the Bureau of Entomology is concerned, it is requested that material be sent in to aid in the investigation of bee diseases. An effort is being made to learn the geographical distribution of the two diseases, so that this information may be available in sending out publications to the bee keepers in infected regions. The same information would be valuable in trying to have new inspection laws passed. We now get many samples from bee keepers direct, but need many more, and the assistance of official entomologists will be greatly appreciated.

This paper brought out considerable discussion. In reply to a number of questions, Mr. Phillips stated that the diseases of bees have spread to a far greater extent than was supposed, and that he is particularly anxious to obtain samples from suspected hives from entomologists and bee keepers throughout the country. The best time to inspect apiaries is during the summer months, and all hives in a state should be examined. He called attention to the ignorance of some of the inspectors now doing this work. In one of the western states his attention had been directed to an inspector who examined the honeycomb by piercing it with an awl. The same instrument was used throughout the district, without disinfection, and in this way the disease had become generally established.

Mr. Britton remarked that a law providing for the inspection of apiaries is pending in Connecticut and Mr. Washburn stated that in Minnesota some of the leading bee keepers desired him to take charge of this work, but he had considered it inadvisable to do so.

Mr. Bruner called attention to the habit in Nebraska of desiring

inspection and work of all kinds to be carried on by the entomologist, but of the tendency of the legislature to make no appropriation for the purpose of paying for such additional service.

A paper was presented as follows:

SHOULD STATE DEPARTMENTS CONDUCT PUBLIC SPRAYERS?

By T. B. Symons, *College Park, Md.*

As the title of this paper indicates, the object in view is to bring out a general discussion of this subject rather than discuss it at much length from my standpoint. It was a question in my mind whether it was even appropriate to present it to this meeting, but after mentioning this fact to our secretary, he was good enough to place the same on the program.

I believe that we all feel much gratification at the great progress made throughout the country in the application of insecticides and fugicides during the past few years. These improved conditions in the treatment of many crops to control the various pests have been brought about by numerous agencies. The increased number and activity of many common pests has led to greater efforts, not only by the growers themselves, but by those charged with the duty of aiding in controlling the pests in the United States Department of Agriculture, the state departments, the agricultural colleges and experiment stations and other organizations, and not the least by private manufacturers of various insecticides.

Referring particularly to the San Jose and other scale insects as well as other common pests, I believe that you will all agree with me in stating that the progressive orchardists or growers of other crops have no fear of the more common pests, especially the San Jose Scale or those that can be controlled by efficient spraying. If this is the case, and it is so far as the territory with which I am familiar is concerned, is it not our duty to spend every effort to bring about this condition among the small growers, who many times only grow fruits especially for the home consumption, and particularly those persons in small towns and villages who may have only a half dozen trees in the backyard which need treatment, but the trouble and expense of securing spraying apparatus and time for the work, as well as knowledge of conducting the same, are difficulties which many of them will not surmount, even if they are inclined to give the trees or plants attention.

I believe the aim of all of us to continually induce the grower to secure his own spraying apparatus is the correct one, for there is no doubt of its desirability, not only for spraying, but for other purposes on the farm, and the convenience of being able to conduct spraying when opportunity and favorable conditions present themselves. It also has been our aim in Maryland to induce persons to conduct public sprayers in different parts of the state, where their service is needed, but we have signally failed in promoting such business enterprises, due I believe in part to ignorance on the part of those persons who could undertake it and the consequent failure to recognize the opportunity for a remunerative income.

Thus from time to time requests from small growers or citizens in towns who have infested trees would come and still come to my office, reading something like this: "If you will advise me who I can secure to do my spraying, I will gladly order same done, but circumstances are such that I cannot do it myself." This condition existing in many parts of our state led us to devise some means of meeting it.

In providing public sprayers, the following points were to be considered:

First, Should a state department conduct public sprayers? Is it a good policy to pursue?

Second, How should they be conducted, as a source of income, or expense, or should charges be made to cover costs and general expenses?

The board of trustees permitted me to give the matter a trial, conducting them on a basis to cover all expenses. Accordingly, we located three rigs in different parts of the state with the especial purpose of treating orchard, shade or other trees and also small orchards in small towns and villages for San Jose Scale or other scale insects.

It is only necessary to discuss briefly the operation of one in this paper.

The rig, which consisted of an eclipse barrel sprayer fitted with two leads of hose, small boiler and other vessels, horse and wagon, etc., carrying materials for making the lime sulphur solution, commenced work in Hyattsville, Maryland, about March 20th, 1907. It continued to work during favorable weather until about April 25th, when the opening of the buds prevented. In this time it visited over forty-five different places and sprayed effectively about twenty-five hundred trees and considerable ornamental shrubbery, hedges, etc., with the lime sulphur wash. Under the excessive charges for labor and team incurred by this rig, a charge of 10c per tree was made to

cover expenses in spraying ordinary trees, but the cost, of course, depended upon the size of the trees, their accessibility and the number at one place. In some cases a greater charge was made, but 10c was about the average. I may add that no complaint was made with any charges imposed and where there is a small orchard to be treated, a charge of 5c per tree will cover costs.

The citation of the work of this sprayer can not be taken as what a similar rig can do under ordinary or favorable conditions, as there were many obstacles which entered into its operation to prevent maximum work.

The operation of the three in different parts of the state demonstrated that they filled a long-felt want and that the public sprayer could be conducted without expense to the department. They were popular in each district operated and there is a demand for many more in other parts of the state this coming season. Our aim in inaugurating this work was first to afford immediate relief in the treatment of trees that otherwise would have been killed or served as distributing agencies for these pests, and second to demonstrate to our people that a public sprayer can be conducted on business principles; with the final aim and desire that private persons would relieve the department by taking over these spraying outfits and conducting the work as a private business. This was the result with one of the outfits started last spring. The man having charge of it desires to conduct it privately this winter and spring.

The question is asked: That in states where the San José, oyster shell and other scale insects or other important pests to our fruit or shade trees as well as pests of other crops are generally disseminated and controlled similarly, should we confine our energies in either conducting spraying demonstrations or advising what should be done, or should we do everything where conditions will permit to provide means in order that the citizens of our small towns and villages, as well as suburbanites and small growers, can have their trees effectively treated at a reasonable cost?

In conclusion, it is unnecessary to add that the conducting of these public sprayers entails a considerable amount of executive and detail work, which takes one's time from experimentation and investigation, but is it not our duty to employ to the greatest advantage the remedies already known for many of our destructive pests?

I would be glad to hear some discussion on this subject as to the manner in which these conditions are met in other states and the opinion of members as to policy of state departments conducting public sprayers.

Mr. J. B. Smith stated that conditions in Maryland are very similar to those in New Jersey. In the latter state the Experiment Station does not consider it advisable to conduct public sprayers. In fifteen or twenty localities spraying is being attempted in a wholesale way by private individuals, and the Station is doing its best to encourage this kind of work.

Mr. Burgess considered the work which Mr. Symons had described as very important and believed that after parties had been properly trained by the state force, that many of them would take up spraying as a business enterprise. This would relieve the state department and give the owners of trees an opportunity to secure competent men to do their work.

Mr. J. L. Phillips favored starting the work in this way and encouraging private parties to continue it.

Mr. H. T. Fernald remarked that more spraying is now being done than ever before, but that in spite of this, losses caused by insect pests are increasing. Under such conditions, there seems to be a question whether present methods of control will ever be sufficiently effective by themselves, and he believed that the time had come to search for new and better methods than those at present made use of, to add to our present weapons.

Mr. Fletcher called attention to the wonderful development in all lines of economic entomology in the last few years. This shows that the entomologists have been working as well as the insects. The world has never seen such work in economic entomology as that being carried on in Massachusetts against the Gypsy moth and in Texas against the cotton boll weevil. During the past year the United States government appropriated $650,000 to fight insects, a thing which ten years ago would have been considered utterly absurd. He believed that what is needed is more work of the same nature as is now giving good results.

Mr. Fernald replied that he recognized that many new lines are now being worked on, and the importance of paying attention to these is the point he wished to urge. The cases of the Gypsy moth and boll weevil work are examples of what he had in mind, for in spite of all that is being done to control these pests, the area of infestation is constantly extending. He felt that spraying and other methods now in use are of great value, and that we cannot afford to neglect them, but after all, they alone would prove insufficient and that it is the duty now of the economic entomologist to investigate all possible lines of the subject in the hope of discovering other methods of control to add to those already in use.

Mr. Sanderson was decidedly of the opinion that the New Hampshire fruit grower should spray. If new and better methods of controlling insect pests are being investigated they should not be announced until their utility is thoroughly demonstrated.

Mr. J. B. Smith stated that he did not believe that entomologists should hold back information or suggestions which might be of benefit to their constituents. If the people of one state were twenty-five years behind the times, it did not seem right to wait for them to catch up with the procession.

Mr. Bruner gave a statement of some interesting experiences which he had in Nebraska, with special reference to the distribution of fungus diseases affecting insects. As a general proposition he did not consider these diseases a particularly valuable means of controlling injurious insects.

Mr. Britton presented a paper entitled:

TESTS OF VARIOUS GASES FOR FUMIGATING NURSERY TREES

By W. E. Britton, *New Haven, Conn.*

The object of these tests which I am about to describe briefly was to ascertain if there is not some gas that can be used more conveniently than hydrocyanic acid gas, especially in fumigating small lots of trees, cions and bud sticks. For this purpose it is necessary that the materials be reasonably inexpensive and comparatively harmless to the operator as well as to the trees. We therefore selected carbon disulphide, carbon tetrachloride, sulphuretted hydrogen and chlorine, and for purposes of comparison a few tests were made with hydrocyanic acid gas, the latter being given three different quantities and three different periods of time. These tests are merely suggestive, and no conclusions should be drawn until more work has been done. We are not yet recommending that hydrocyanic acid gas be replaced by any of the others tested.

The trees were fumigated in a long narrow box containing ten cubic feet of space. In order to ensure a more uniform distribution of the gas, two generating dishes were used, one being placed near each end.

The trees were apple and peach of several standard varieties, all more or less infested with San José scale, though none so badly as to affect seriously their vitality. Roots and tops were both fumigated and the trees properly labeled and planted in nursery rows, where they could be watched during the season. For comparison untreated trees were planted alongside to serve as checks.

As we had no basis from which to compute quantities of some of these gases, guesswork had to be employed, but we sought to kill the scale, and expected that many of the trees would be injured. I am now convinced that further tests, especially with carbon tetrachloride, in smaller quantities, are desirable, and possibly it may prove to have some value as an insecticide.

Volatile Liquids

Carbon disulphide.—Preliminary tests taught us that there is more or less trouble in volatilizing the liquid rapidly at ordinary temperatures. Where a large quantity is used, the period necessary for volatilization is so long that the roots may dry out and the trees are injured. Cast iron stew pans were adopted as generating dishes, and after heating to nearly 200° F., one was placed near each end of the box above the trees. A small hole through the cover of the box enabled us to pour the liquid through a funnel into the heated dish. The holes were stopped with corks and the carbon disulphide all volatilized in a few seconds or minutes, according to the quantity, while without the heated dishes several hours were necessary in some cases. Quantities of the liquid varying from ten to eighty fluid ounces per one hundred cubic feet of space were given periods of time varying from one to four hours. At the rate of ten ounces per one hundred cubic feet for one hour, 4.3 per cent of the scales survived, and one tree died. Similar proportions for the same time at 59° F. (the dish not being heated) gave a surviving percentage of 19.2 per cent. Aside from these all scales were killed, and no trees injured until given a period of three hours with a quantity of carbon disulphide equivalent to sixty ounces. Above this about half of the trees failed to grow.

Carbon tetrachloride.—The quantities used of this liquid varied from one to eight ounces, and the fumigating period from two to six hours. All scales were killed, and no trees were injured, where thirty ounces per one hundred cubic feet or less of the liquid was used, with a fumigating period of two hours. Greater quantities of the liquid caused injury, and killed some of the trees. This liquid was also volatilized by means of heated pans. It is non-inflammable, and is not very poisonous to the higher forms of animal life.

Gases Generated by Chemical Action

Hydrocyanic acid gas.—This gas was generated in the usual way with one ounce potassium cyanide, two ounces sulphuric acid and four ounces water for each one hundred cubic feet of space. In each case all scales were killed. In one case where these qauntities were used

and the stock fumigated for one half hour, one tree out of ten died. In another case where the same quantities of chemicals were used and the stock fumigated two hours, one-tenth of the trees failed to grow. In all other cases of tests with this gas the trees lived and grew nicely. The largest quantity used was three ounces of cyanide, and the fumigation period was one-half hour. Two ounces for two hours produced no injury.

Sulphuretted Hydrogen.—Generated from iron sulphide, sulphuric acid and water in the following proportions:

Iron sulphide	20 ounces
Sulphuric acid	80 ounces (fluid)
Water	32 " "

In this proportion nine, twelve and one-half, and twenty-five pounds of iron sulphide per one hundred cubic feet of space for one hour were employed, the last quantity only causing injury to the trees. Where this amount was used and the trees fumigated for two hours, only two out of ten trees were killed. The scales were killed in all cases.

This gas was rather inconvenient to use, as it takes a long time to generate it.

Chlorine.—Generated from bleaching powder, sulphuric acid and water in the proportions given below:

Bleaching powder	14 ounces
Sulphuric acid	17 ounces (fluid)
Water	70 " "

The quantities used in these tests varied from 8.6 to 34.7 pounds per one hundred cubic feet, and were probably all excessive. As we expected, all of the scales and most of the trees were killed.

In reply to a question, Mr. Britton stated that he had not used acetylene gas for fumigating fruit trees. Carbon tetrachloride appeared worthy of further test.

Mr. Hunter mentioned the fact that Mr. Sanborn had used acetylene gas to destroy plant lice on cucumber plants in Texas.

Afternoon Session, Saturday, December 28, 1907

On re-assembling at 1 p. m., three papers relative to the cotton boll weevil work were presented, as follows:

THE POSSIBILITY OF REDUCING BOLL WEEVIL DAMAGE BY AUTUMN SPRAYING OF COTTON FIELDS TO DESTROY THE FOLIAGE AND SQUARES

By Wilmon Newell and T. C. Paulsen, *Baton Rouge, La.*

The most important step in insuring a good crop of cotton in the boll weevil infested region of the South is the early fall destruction of the cotton plants in order to kill the immature stages of the weevil contained in the squares and bolls, to destroy the food supply of weevils already adult and to lengthen the period through which the insects must survive until the appearance of the following year's crop. So completely has this been demonstrated by the experiments of the Bureau of Entomology in Texas, and more recently by Prof. W. D. Hunter in an enormous field experiment in southern Texas, that discussion of this point is entirely unnecessary.

The great objection upon the part of planters to fall destruction of the cotton plants is that the cotton crop cannot be picked out early enough so that the plants can be uprooted and burned at the time necessary to insure destruction of the greatest number of weevils, for the labor problem in Texas and Louisiana is at present second in importance only to the boll weevil problem itself.

A method of practice which would destroy the weevils and their food supply (leaves, squares and green bolls) early in autumn and at the same time permit greater leisure for gathering the crop, has long been recognized as a desideratum. The possibility of spraying to destroy all green portions of the cotton plant, without affecting thereby the lint in bolls still unopened, was discussed at length as much as two years ago by Prof. W. D. Hunter and the senior author. At that time we saw no possibility of the plan being practical.

During the past summer the subject was again brought up by Dr. T. J. Perkins, an extensive planter of Redfish, La. Doctor Perkins had had experience in destroying the water hyacinth with sprays, and being also a practical cotton planter, he believed that the same plan could be made applicable in the warfare against the weevil.

The writers accordingly decided to make a few experiments in a small way to determine what could be accomplished along this line. We first experimented with substances which we knew to be destructive to plant life, such as common salt, white arsenic, copper sulphate, etc.

Through the courtesy of Capt. J. F. McIndoe, Corps of Engineers, U. S. A., we were furnished with directions for preparing the mixture of white arsenic and sodium carbonate used so successfully by

the army engineers in destroying the water hyacinth in the bayous and navigable streams of the southern states. The cost of the ingredients, and particularly of the arsenic, showed that the use of this preparation, even though it might meet all requirements, would involve an outlay too great to make its use profitable in the cotton fields.

It was also thought that the cotton plants might be killed by "girdling" the base of each with a flame from a gasoline blow torch, and this was accordingly tried. With cambium layer and bark entirely burned off, the plants died immediately and the green bolls afterwards opened fairly satisfactorily. However, a much more severe burning was necessary to kill the plant than was anticipated, from five to ten minutes' application of the flame to the base of each plant being necessary to insure death. On account of the labor involved this method was put aside as impracticable.

Spraying solutions were next tested, most of the experiments being made during the month of September. Several healthy plants were sprayed by hand with each solution tested, with the general results indicated below.

A 5% solution of common salt burned the foliage rather severely and caused some of it to shed, but the plant continued to grow and put on foliage and squares. The application of the salt solution to the larger unopened bolls caused them to open suddenly, without the lint maturing properly.

A 5% solution of bicarbonate of soda produced little effect, except that some leaves and squares were wilted. In six days after spraying the plants had practically recovered and were growing rapidly.

A 5% solution of ordinary lye severely burned the foliage and caused many leaves and squares to fall. It also seemed to scar the unopened bolls severely and the plants almost immediately started to put on a new growth. The caustic nature of the solution was also objectionable.

A 2% solution of hydrochloric acid burned some leaves and caused about 40% of the foliage to drop, but in two days' time an abundance of new foliage and fruitage was being put forth.

A 3% solution of white arsenic in water, dissolved by long continued boiling, killed the cotton plants outright and no "second growth" appeared at any time after spraying. The larger bolls were however forced open almost at once, with the result that the lint and seed had no opportunity to mature.

A solution containing 5% of white arsenic and 3% of carbonate of soda did not produce effects materially different from those produced by the 3% arsenic solution. All the foliage was killed, the larger

bolls opened and furnished fair lint, with improperly filled seed, while the smaller bolls either dropped off or decayed after opening slightly.

Copper sulphate used at the rate of 5 lbs. to 50 gallons of water scorched the foliage slightly and induced gradual shedding of leaves. This shedding, however, was accompanied by a constantly increasing rejuvenescence of the plants.

A 10% solution of iron sulphate killed leaves, squares and the smaller bolls.

A 5% solution of iron sulphate was next tried. The action of this solution was more gradual than that of the 10%. In 24 hours after application some leaves were burned. Three days after the application blossoms and forms were dead and on the fourth day the shedding of leaves, squares and forms was well under way. By the fifth day there was practically nothing upon the plants that could serve as food for the weevils. This slow killing of the foliage also gave the large bolls, not open at time of spraying, an opportunity to mature, for on the fifth day also the first of these opened. For several days afterwards these bolls opened rapidly and from those that were three-fourths grown or over at the time of spraying, fair lint was secured. Lint in bolls which were *open* at time of spraying was slightly discolored. Later a very few green shoots were put out by these plants. We have given the results of this experiment thus in detail for iron sulphate meets the requirements better than any other substance tried and it is also the cheapest.

The iron sulphate and salt solutions having separately proved the most promising, they were tried in combination. A solution containing 5% of each did not show any advantage over the 5% solution of iron sulphate used alone, and the plants sprayed with the former took on new growth to a marked extent.

Combinations of iron sulphate and white arsenic were tried, but gave no indication of being better than iron sulphate alone.

A 1% solution of iron sulphate was not found to be strong enough. A 3% solution of the same material was practically as effective as the 5% solution, except that the plant recovered to a certain extent and in a couple of weeks put out more new foliage than was desirable.

Taking a comprehensive view of these experiments, we see that arsenic solutions proved effective in killing the plants, but are too expensive, while iron sulphate solutions meet the requirement of killing the plants slowly, while at the same time permitting the larger bolls to mature and open. The latter—nearly grown bolls—it may be remarked, are the ones which are lost when the plants are uprooted and burned; smaller bolls would not figure in the production, as in

ordinary seasons they would be killed by frost, even were the plants not destroyed. Copperas, or iron sulphate, may be purchased in quantity at from 1 to 1½ cents per pound, hence weak solutions of it are not expensive.

We have made no attempt to experiment with these solutions on the scale of field operations, as time did not permit. There still remains the problem of applying this copperas, or other solution, to the cotton plants with a mechanical sprayer, making the application thorough enough to be effective in destroying the weevil's food supply and at a labor cost sufficiently low to make the method practicable. In this connection, however, it should be borne in mind that the lint contained in the grown and nearly grown bolls at the time fall destruction of the plants must be practised, constitutes a considerable part of the crop in weevil-infested sections, and by the amount of lint secured from such bolls, if the spraying prove otherwise successful, must we compute the loss or gain from such an operation.

From the foregoing it will be noted that destruction of the foliage, squares and blooms on the plants sprayed with the various solutions was usually followed in a week or ten days by new shoots and leaves being put out by the plant. Our experiments were made during the early part of September, just after the period of intense summer heat and just prior to the time when the second growth normally appears in all cotton fields. Should spraying to destroy the foliage be found efficient such spraying would be done, not in September, but between October 15 and November 1, at a time when little if any second growth would ordinarily be induced. We do not think therefore that the factor of rejuvenescence in the plants following the spraying would, under field conditions, militate against the success of the method.

The discoloration of lint in bolls open at the time of spraying would not be a difficulty hard to overcome, as it would only be necessary to have the spraying machine follow the pickers, thus spraying the cotton when no bolls are open.

THE FIRST AND LAST ESSENTIAL STEP IN COMBATTING THE COTTON BOLL WEEVIL

By W. E. Hinds, *Auburn, Ala.*

(Withdrawn for publication elsewhere.)

Mr. Sanderson remarked that these papers bring out in detail the fact which he had previously demonstrated, that the cotton stalks must be destroyed in the fall.

Mr. Hunter stated that the farmers in the section where his experiment was tried were anxious to have it repeated this year.

A LARGE SCALE EXPERIMENT IN THE CONTROL OF THE COTTON BOLL WEEVIL

By W. D. Hunter, *Washington, D. C.*

(Withdrawn for publication elsewhere.)

A paper was read as follows:

THE ECONOMIC BEARING OF RECENT STUDIES OF THE PARASITES OF THE COTTON BOLL WEEVIL

By W. D. Pierce, *Washington, D. C.*

The utilization of parasites in the control of injurious insects generally has taken only the form of introduction from other localities or from foreign countries. Notable instances may be cited in the introduction of *Scutellista cyanea* from Africa into California to combat the black scale (*Saissetia oleae*), and the very recent introduction of this same parasite from California into Hawaii, there to attack a different species of scale in the same genus. The successful introduction of *Rhogas lefroyi* from southern India into the Punjab by Mr. Maxwell Lefroy in order to restore the former condition of control of the bollworm by this species, which was killed out by the cold winter, and the more important fact that where introduced the parasites regained much of their former control is another example of the same kind. Mr. F. M. Webster, in a paper read before this association last winter, cited a number of important cases of valuable parasites in the control of cereal and grain crop insects.

Contrary to earlier suppositions, it is now apparent that parasites and predatory insects bear a very considerable part in the control of the boll weevil. It is important to note that the boll weevil parasites are indigenous species that have been attacking native weevils, but which now, in many instances, seem to be transferring their attention to the great enemy of the cotton plant. Since the control by these inimical insects can be aided by several distinct methods of practice, it is considered justifiable to present the following remarks:

The preliminary studies which have been necessary in order to perfect any methods of economic treatment have involved the collection and individual examination of infested cotton forms during 1906 and 1907 which have contained over 54,000 weevil stages, exclusive

of eggs and very young larvae killed by the proliferation of plant tissue. These were gathered at many places over an area of approxmately 200,000 square miles, at many times and are representative of all the component biological or geographical regions infested by the boll weevil in the United States.

During 1907 the average control of the weevil by parasites was ten per cent against four per cent in 1906. They are not, however, the principal element of control. Out of 62 per cent mortality in 1907, 32 per cent was due to heat and other climatic conditions, while 20 per cent were killed by predatory ants. This gives then 30 per cent as the sum of insect control.

The utilization of these insects belongs in three distinct groups of economic treatment. The most important group consists in the application of strictly cultural methods to farm practice and is therefore under the control of every cotton grower. The next group takes advantage of the known rotation of hosts and also belongs under farm practice. The third group is the simple introduction of parasites and is really in many cases preliminary to the two preceding.

The first mentioned group of.methods involves early planting, wide spacing, and the use of determinate, short limbed, square retaining varieties of cotton, as explained in the following paragraphs.

The study of the activity of the parasites on weevil stages in different conditions demonstrated that the most favorable condition for parasite work was the dried hanging square. It appears that when the weevil attacks the squares or bolls the plant produces a corky absciss layer which causes the infested form to fall to the ground. There is a decided tendency among certain varieties and less so in all varieties to fail in forming a complete absciss layer and hence the infested part is caused to hang. When this has become dry, it affords the best possible condition for parasite attack since most Hymenopterous parasites require heat and light for successful work. During 1907 the average parasite control in hanging squares was 30.45 per cent, in fallen squares 4.67 per cent, in hanging bolls 5.44 per cent, and in fallen bolls 2.5 per cent. This positive demonstration of preference contributes a suggestion for economic application. It may be possible that plant breeders can develop a variety of cotton which will have this tendency in such a marked degree, that the possible parasite control will exceed the total control by all causes in varieties which shed all infested forms. At present the total control in hanging and fallen squares does not greatly differ.

Careful studies have demonstrated a preference for squares fallen in the sun over squares fallen in the shade, and for fallen squares on

the prairie over fallen squares in wooded country. The reason is obvious enough. The parasites choose the dryest and lightest condition to be found. These very valuable observations give strong confirmation to the value of the cultural methods, in particular the recommendations that the cotton be planted in wide rows or checked and that determinate varieties and varieties with the least amount of foliage be used.

A comparison of fields in like conditions, except for the time of planting at several different places, shows that the earliest planted field in each case fared the best through the early part of the summer at least. This is believed to be because of the rotation of hosts by the parasites, and the possibility of the hibernated parasites attacking the boll weevil as the first or second spring host in the earliest planted fields, and the necessity for one or more generations on other hosts in the latest planted fields. The fact remains, however, that early planting is advantageous.

The second group, or control by the rotation of hosts, consists of the encouragement of the spring host plants for co-host weevils, the elimination of summer host plants in order to force over the parasites, and the fall destruction of the cotton plant to insure hibernating co-hosts for the parasites.

At present the average percentage of parasitism is very variable for localities quite close together. This is directly due to the very peculiar distribution of the parasites. No one species is of primary or even secondary importance over the entire infested territory. Six species are known to hold these positions in various portions of our territory. They are, in order of greatest importance *Bracon mellitor, Catolaccus incertus, Eurytoma tylodermatis, Microdontomerus anthonomi, Cerambycobius cyaniceps,* and *Cerambycobius n. sp. Bracon mellitor* is predominant in Texas except in the central and eastern portions. *Catolaccus incertus* appears as most important in south Texas and Louisiana. *Eurytoma tylodermatis* is at its best in north central Texas. *Microdontomerus anthonomi* is very important in central Texas. *Cerambycobius cyaniceps* predominates in northeast and east Texas and in northwestern Louisiana. The new species of *Cerambycobius* is known to occur only at Victoria, Hallettsville and Brownsville, Texas, and Alexandria, Louisiana. *Microdontomerus* is a new genus of the torymid sub-family *Monodontomerinæ* and furnishes the first species in that family known to attack Coleoptera. This species was new to science in 1906 and a very insignificant factor in the control of the boll weevil. In 1907 it appeared on places carefully watched in 1906 and where it was not found before and this year

became of real importance. The new species of *Cerambycobius* in the same manner is struggling upward for recognition. The rapidity with which these new parasites have adapted themselves to the boll weevil, together with the facts that parasite attack begins within two weeks of the invasion of new territory by the boll weevil, and that six new primary parasites were added to the list during 1907, has caused us to conclude that change of host relationships is not an uncommon thing in at least some groups of parasitic insects.

The peculiar distribution of the parasites and the appearance of new parasites each year, prove that the boll weevil is not the original host of any of them in this country. In other words, the parasites are all native insects and hence are derived from native hosts. With a few exceptions these native hosts are more or less closely related to the boll weevil. *Bracon mellitor* is recorded from three species of Lepidoptera and from seven species of *Curculionidæ. Catolaccus incertus* has been bred from two species of *Bruchidæ,* and thirteen species of *Curculionidæ. Eurytoma tylodermatis* has been bred from *Bruchidæ* and *Curculionidæ. Cerambycobius cyaniceps* is known as a common parasite of *Cerambycidæ, Bruchidæ,* and *Curculionidæ. Microdontomerus anthonomi* attacks one species each in the *Bruchidæ, Anthribidæ* and *Curculionidæ.* The new species of *Cerambycobius* also attacks species in these three families.

The presence of these parasites on neighboring weevils has afforded opportunity for an extensive study of weevil biologies in which over 125 weevil species have been more or less intimately studied. Some of these weevils have ranked as injurious species in literature and others of equal importance have never received economic mention. The study of the biologies and parasites of these species has produced several points of value, all of which will be published as rapidly as time permits.

From the standpoint of the boll weevil problem, it is of course essential that such an important point as the diversity of host relationships should be utilized economically. The first phase of this diversification is an adjustable rotation of hosts, which, of course, varies in consecutive years just as the variable climate affects the seasons, and as other conditions affect the abundance of the host plants. The parasites in the main attack weevils of few generations and consequently must have several species of hosts in a season. When a parasite matures, it evidently seeks as its host the most abundant related host species and attacks that. The boll weevil is the predominant weevil species in Texas and is therefore the recipient of all parasites in doubt, so to speak, about their next host. When the cotton is late,

it is necessary that there be from one to three generations of parasites on the spring weevils, thus producing a good supply of individuals at the time the boll weevil begins work. It is, however, best that the boll weevil receive the earliest generation possible in order to prevent a division with the other hosts. To insure the proximity of parasites to the cotton field in early spring, it appears advisable to have plants such as dewberry or blackberry in hedgerows, or to have red haw trees near. In the first case the strawberry weevil, *Anthonomus signatus,* is quite generally distributed and serves as an available host for *Catolaccus incertus.* The *Crataegus* trees are the food plants of three or four species of weevils which are co-hosts with the boll weevil.

During the summer season, there is an extensive series of host weevils in neighboring weeds which can be made to give up many parasites, if the weeds are cut when at their height, about twice during the summer season. The practice of making hay in the vicinity of cotton will bring about similar results. The principle is that the parasites will be forced to seek new hosts and will take the predominant related host—namely, the boll weevil. This is not a theory, for it is substantiated by definite experiments on the cotton farm at Dallas.

Adjacent to one edge of the Dallas experimental farm was a high hedge of *Ambrosia trifida* infested by *Lixus scrobicollis,* which is usually highly parasitized by *Eurytoma tylodermatis.* In 1906 this portion of the field showed less than three per cent parasitism due to this species in hanging squares. At the time of cutting the weeds, check examinations were made and two weeks later another was taken, showing a considerable gain in attack by *Eurytoma,* which netted over 30 per cent. The careful records kept on this field preclude the possibility of ascribing this result to any other cause.

In southern Texas where the predominant trees are leguminous, any cause which would tend to check the fruiting of the huisache and mesquite in alternate years or at irregular periods, would tend to cause an overthrow of the normal habits of the many parasites of the bruchids in the pods and drive them to the boll weevil. Our attention was forcibly called to a particular field at Victoria with high parasitism, where the presence of the new *Cerambycobius* on the boll weevil was first noticed and was definitely traced to the huisache trees which had failed to fruit this year.

The most important of all the cultural suggestions for control of the boll weevil is the early destruction of the cotton stalks. Owing to the probability that the parasites can hibernate better when attacking the native weevils, this practice seems advisable in order to drive the

parasites over to other hosts in time to insure their establishment. Having safely disposed of an important element of control and secured its reappearance, the stalks can be burned about fifteen days after cutting, thus establishing another important method of control. The total gain is greater than that to be had by allowing the parasites to hibernate on the boll weevil.

Finally there remains the third group of parasite methods, known as direct propagation, including the transfer of breeding material or parasites, the use of field cages for infested squares, and the establishment of new ant colonies.

After locating places where a very high percentage of parasitism prevails, either on the boll weevil or on other weevils, large quantities of infested material may be gathered and transported to the laboratory or to experimental fields where the parasites may be directly hibernated. In case of the existence of secondary parasites, the material must be placed in breeding cages in the laboratory. As this is a common practice, thoroughly understood by all entomologists, it need have no further treatment. It has proved of direct and immediate value when tried.

A similar method of treatment is at hand for all planters. They may gather infested cotton squares and place them in 14 to 18 mesh wire screen cages in the field with the assurance that all parasites and only a small portion of the weevils will escape, thus by a simple measure increasing the *pro rata* of parasites.

Since the little fire ants are very important enemies of the boll weevil, it is desirable to have some way of increasing their usefulness. It appears that they are very fond of fly larvæ in fresh manure and transfer their colonies to it frequently, and that by boxing this manure the colonies may be secured very easily. The method has not yet been tested. The time of swarming is the critical time for establishing colonies, for then a single queen is sufficient.

In conclusion it may be said that a decided gain is apparent in the amount of parasite control, that the cultural methods of cotton cultivation are most favorable to parasite propagation, that the host relations of the boll weevil parasites can be more or less easily changed, that immediate results have been obtained by the release of parasites, and finally that the present investigations are bringing to light evidence that must cause important modifications of some of the accepted ideas as to the host relationships of parasites.

The next paper presented was entitled:

THE CORRELATION BETWEEN HABITS AND STRUCTURAL CHARACTERS AMONG PARASITIC HYMENOPTERA

By Charles T. Brues, *Public Museum, Milwaukee, Wis.*

The problem of insect parasitism has always been a fascinating one from the standpoint of pure science, but during recent years it has become an increasingly important one for the economic entomologist. Indeed it has been discussed so fully and in so many aspects that I feel much hesitancy in adding the present remarks to the writings of many able entomologists better acquainted with the more or less heterogeneous mass of facts so far accumulated on the subject. My only desire is to present the matter in a somewhat different light.

The rapidity of increase among injurious insects which become introduced into new regions where they are not kept in check by their parasites was early noted and commented upon by entomologists, and certain experiences in our own country within the past few decades have brought out very clearly the fact that of all the forces which control the comparative abundance of related insects, the presence of their parasites is the most vital.

The balance maintained by the struggle for existence between species is immediately and violently disturbed if the parasites of any particular species be removed. Such a form suddenly begins to increase in numbers, reproducing itself at a phenomenal rate approaching the geometrical progression, which would theoretically obtain if every individual were permitted to reach maturity and reproduce itself. When the food supply is sufficient it will quickly become dominant over related species. Such conditions of rapid increase occur almost exclusively as the result of the introduction of an insect into a locality where its natural parasites do not occur, and are on this account most often brought to our notice by the rapid spread of injurious species.

Following the acceptance of this principle, was the attempt on the part of economic entomologists to combat accidentally introduced insects by purposely introducing the parasites which prey on them in their native region. The experiment has been tried a number of times under varied conditions and has proven almost universally successful in measure to warrant its trial whenever feasible.

There are vast numbers of parasitic insects, particularly Hymenoptera. These are widely distributed, and a very close relationship exists between allied species and genera inhabiting widely separated regions. It would be natural to suppose, therefore, that the transfer of an insect from one region into another would lay it open to attack

from some of the forms closely related to parasites which control it in its native environment. We have abundant proof however that such is not usually the case, and it is a matter of general agreement that the likelihood of any sudden variation appearing in the life history of a parasite, due to an introduced host, is very slight. Such a generalization is not universally true, especially among members of the dipterous family *Tachinidæ,* but seems to ordinarily apply, and does so particularly well, to the groups of parasitic Hymenoptera to which I shall confine most of my remarks.

Upon what, then, does this mutual adjustment between parasitic species and host species depend?

Entering the field of speculation, it is evident that there are a number of possible factors which may determine it, and I shall endeavor to consider the more important in turn.

That the physical form or size of a species has an important bearing on the matter of parasitism is undoubted. Parasites which live singly in the bodies of their hosts must necessarily confine their attacks to species which will furnish them with a proper amount of food to mature. On the other hand, it is imperative that the body of the host be entirely consumed at maturity in the case of parasites which pupate *in situ;* or in the case of species which leave the host for pupation, that the emergence of the delicate parasitic larva may proceed without accident.

Many of the smaller parasitic species, particularly certain *Chalcididæ,* may develop in large numbers within a single host. Such species ofter undergo remarkable multiplication during development, and the number of young is regulated to suit the food supply. The adaptability of certain forms in this respect has often been observed. For example, the well-known and widespread *Pteromalus puparum* attacks a considerable series of butterfly larvæ, ranging in size from rather small to large species, and the number of specimens derived from a single caterpillar is roughly proportionate to its size.

Such species are however decidedly in the minority, and within reasonable bounds, the size of an insect is a limiting factor in the determination of its parasites. This does not necessitate that all of its parasites be of uniform size, since the number of eggs laid in a single host usually determines the number of emerging parasites. For example, there may issue from a parasitized cocoon of the common Cecropia moth, but a single specimen of the large Ichneumon-fly, *Eremotylus macrurus,* while dozens of specimens of the small *Cryptus extrematatis* regularly issue from a single cocoon of the same moth. This sort of adjustment is almost universal, and most insects which have been

extensively studied are found to harbor parasitic species of each type. A similarity in form of body or type of structure is generally seen to exist between the hosts in cases where a parasite attacks several different insects. Thus all of the hosts of the aforementioned *Pteromalus* are caterpillars, and the same rule obtains among others, for example, among species of egg-parasites, which always attack insect eggs, although not always those of the same insect. Remarkable exceptions to this are nevertheless to be noted, for instance, the Chalcidid genus *Eupelmus* (*sensu lato*), which attacks both the eggs and larvæ of numerous species belonging to six natural orders of insects.

It is seen, however, that while the hosts of a given species, genus, or larger group are usually of similar form or habitus, that this similarity generally depends upon relationship and is not merely accidental, for we do not find ordinarily that insects presenting the same general appearance will have the same parasites. A species of *Ichneumon, I cyaneus* Cres., which attacks both saw-fly larvæ and caterpillars, is a notable exception.

In other words, dissimilarity seems to act more strongly as a deterrent than similarity does as a persuasive, in regulating parasitism.

Occurrence in a similar habitat acts very evidently in some cases to widen the range of hosts attacked. This is especially noticeable in the case of insects producing galls on plants. We must make allowance for the greater care with which the parasites of these insects have been studied, but it is nevertheless astonishing to see what a wide range of species are often regularly attacked by the same parasite.

The European Chalcid-fly, *Ormyrus tubulosus*, has been minutely studied by Mayr, who has bred it from no less than 27 species of Cynipid galls, and I have from Massachusetts what is apparently the same species, bred from about half as many North American species by the late Dr. M. T. Thompson. The galls formed by the various hosts of this species are many of them entirely dissimilar in form, the only resemblance between them, aside from their gross gall-like form, being their more or less uniform habitat, attached to twigs and leaves.

On the other hand, an isolated environment usually restricts greatly the possible parasites of a given species. A case in point is seen with species living beneath bark or boring into wood. Many groups are represented among the enemies of such insects, but all must come from groups provided with an elongated ovipositor, with which to reach the host for egg deposition. A beautiful case of complete restriction is the Ichneumonid genus *Thalessa,* which attacks certain wood-boring *Siricidæ,* deposting its eggs in the body of its host far within the infested tree by means of its enormously elongated ovipositor. It may perhaps

be urged that natural selection will develop a long ovipositor in any group where it may be of service, but the value of the elongated ovipositor for the separation of larger groups shows that it is an organ that is very slightly influenced by specific exigencies.

Seasonal distribution naturally limits the range of parasitism rather closely, since the time of appearance of insect species varies greatly; and as adult parasites are not long-lived, their hosts must appear at nearly the same time as they do themselves. The tendency is for parasitic species to undergo metamorphosis more rapidly than others, probably on account of their easily assimilated food, and with shorter life-cycle they will tend to pass through more generations in a season than their hosts in many instances. Here I believe lies the reason for the acquirement of more than a single host by some species, although it cannot explain the large number of hosts of some species, nor the several closely related hosts of others.

While some of the probable reasons for the association of host and parasite may be found among the foregoing, there seem to be no cases that can be fully elucidated by either one or a combination of all. Indeed, the very fact that there are so many closely related parasites and so little transfer to new hosts, would almost preclude such a supposition *a priori,* and some more subtle hereditary influence must be sought for.

Throughout the entire parasitic group, there are scattered here and there species which are particularly adaptive, in that they attack several or a number of more or less closely related hosts, while others not far removed taxonomically have apparently but a single one. But in nearly every minor group and in some of the larges ones, there is a well-marked tendency to select as hosts species belonging to another homogeneous group. Thus every one of the seven or eight hundred members of the Proctotrypid family *Scelionidæ,* so far as known, with one single exception of doubtful relationship, is an egg-parasite. Almost every species of the family *Alysiidæ* is parasitic on dipterous larvæ; practically all members of the extensive sub-family *Aphidiinæ* of the *Braconidæ* are aphid parasites, and so we might continue to list many more. There are here also very noticeable exceptions, but they only serve to show the strong tendency toward uniformity which exists everywhere.

Small groups do not always show the increased specialization which we might expect from the uniformity exhibited by so many larger groups, and species in particular may occasionally have almost as great a range in choice of hosts as genera or even larger groups. A case in point is the Chalcidid genus *Trichogramma,* which attacks the

eggs of insects belonging to four orders, one of its species, *T. pretiosa,* preying upon no less than 12 species belonging to two orders, the Lepidoptera and Hymenoptera.

It has often been customary among hymenopterists to assume that a different host species must almost surely have different parasites from those of a related form, even if sharp differential characters could not be observed, but reliance on this physiological character is gradually giving away to a demand for actual structural characters, and recent investigators place little confidence in host relations for the actual separation of species.

Undoubtedly the explanation for the fixity of habits throughout many of the larger groups, is the common inheritance of specific instincts through long periods of time without any, or with but little change, while the varied genera and species of the group have meanwhile been evolved. A habit thus formed has been handed down from generation to generation as the groups have passed into a more and more intricate interdependence, through the evolution of new species in each group. Such will be the natural trend of evolution, and we can readily comprehend how the habits of a group like the *Scelionidæ, Alysiidæ* or *Aphidiinæ* must have originated. The Alysiid are particularly interesting in this respect, as they form a very compact group distinguished from all its relatives with more than usual ease by a single morphological character, which does not allow of the different interpretations to which the characters of most other groups are subjected at the hands of the systematist. In cases where groups are more opinionative, habits themselves usually have considerable weight in the segregation of their components.

Conversely, that the variations from any uniform or related system are due to some sudden change in the nature of a mutation seems probable, and if so, the antiquity of the mutation should in some degree be traceable from a knowledge of the extent of the present variations.

Turning to view this possibility in the light of paleontological evidence, we find that several well-marked cases of unusually variable habits within a genus or small group are evidently associated with antiquity.

Among over one hundred undescribed species of fossil parasitic Hymenoptera, which I am working over from the Miocene shales of Florissant, Colorado, there are several genera that stand out distinctly on account of their abundance. One is the Ichneumonid genus *Pimpla.* It is represented by four or five species, one of which is the most abundant form in the entire collection. Evidently these were as dominant then as our species are at present. We find also that the recorded habits of *Pimpla* are unusually varied.

Another dominant genus resembles the present-day Chalcidid *Torymus* very closely, but on account of a somewhat less specialized wing venation, I have termed it *Palaeotorymus*. There are at least four distinct species from Florissant, represented by many specimens in the collection. Because of its evident antiquity it has had ample chance to give rise to variations in habits, through mutation or otherwise, and we find that the present species of *Torymus* are parasites of gall insects belonging to both the Diptera and Hymenoptera, and apparently of certain Coleoptera and Lepidoptera as well.

Chalcis (including *Smicra, Spilochalcis,* etc.) is another genus that is well represented at Florissant, and recent species of this dominant group attack insects belonging to at least three orders, Lepidoptera, Coleoptera, and Diptera.

That very persistent types are not always the ones to give rise to variations in habits is shown by the occurrence of many species of *Limneria, Ichneumon, Microgaster, Proctotrypes,* etc., in these same Miocene deposits. None of these particular genera seem to have at present a wide range of hosts.

Correlation between very slight characters and certain host relations is very common, and I shall mention one in closing. The genus *Telenomus* contains nearly 175 species of egg-parasites, and is distinguished from the closely allied *Phanurus* by such evanescent characters that many systematists recognize no generic division. Of the entire series only two are known to breed in the eggs of Diptera. Both attack the eggs of *Tabanus,* one in Europe and the other in America, while taxonomically they exhibit particularly well the slight differential characters of *Phanurus,* although they cannot satisfactorily be segregated from the rest of the genus upon a strictly morphological basis.

To judge, then, from the fragmentary evidence so far adduced, we can only suggest that the single explanation which seems applicable to the constancy of some groups and the variability of others, lies in the assumption of a general evolutionary trend toward gradual elaboration, broken here and there by a mutation in habits which has split off the progenitors of certain groups from the conservative majority. The fact that parasitism has undoubtedly originated independently in a number of groups further enlarges the possibilities of complexity in host relations.

A paper was presented as follows:

PRELIMINARY REPORT ON THE LIFE HISTORY OF THE CODLING MOTH AND SPRAYING EXPERIMENTS AGAINST IT

By E. Dwight Sanderson, *Durham, N. H.*

For the past three years we have been working on the life history of the codling moth in New Hampshire, and making experiments to determine the value of spraying at different times. The greater part of the life history work was done by Dr. T. J. Headlee or was under his immediate charge, as was also much of the field work.

It is convenient to commence the consideration of the life history of an insect with a discussion of its wintering habits and then follow it thru the season. Seven large apple trees were thoroly examined by a competent student last spring to determine the position in which the codling moth larvæ hibernate and their mortality. An average of 55 cocoons per tree were found, 70% being on the trunk and 30% on the limbs. Records showing the height of the cocoons on the trunk indicate clearly that more cocoons are to be found just below the crotch and just above the base of the tree, than are to be found midway on the trunk. It seems very evident that the larvæ descend from the limbs to the trunk and ascend from the dropped apples on the ground to the lower part of the trunk to form their cocoons. Eighty-seven per cent were killed by birds, 4% by fungus disease, 3% by cold, and but 5% remained alive. An examination of numerous other trees in the same orchard including the cocoons of 1,086 larvæ showed that 66% had been killed by birds, 9% by cold, 6% by fungus and 19% were alive. The percentage of mortality will of course vary with local conditions, but previous experience reinforces these observations that only a very small percentage survive hibernation.

In the spring a short tube is spun out from the cocoon prior to pupation. In 1906 the average date of pupation for 43 larvæ was May 25, the average length of the pupation stage 20 days, the majority of adults appearing about June 14. In 1907 the average date of pupation for 103 larvæ was June 16, the average length of the pupal stage being 16 days and the majority of adults appearing about July 2. It is interesting to note the difference of four days in the pupal stage in the two seasons. We have not studied the temperature data with sufficient care to determine whether the difference is due to temperature, but such a result shows the necessity for having a large series of individuals upon which to base our conclusions as to the life history of an insect, and also the importance of studying it for several years if its economic importance warrants it. The length of the pupal stage

varied from 3 to 64 days, those pupating earliest in the spring remaining the longest in that stage.

In 1906 the first moth appeared June 9 and in 1907 on June 13. In 1906 the last moth appeared June 26 and in 1907 on July 8. Thus there was a period of emergence of 17 days in 1906 and of 25 days in 1907. It is interesting to note the relation of these dates of emergence to the time of blooming of the apple. In 1906 the first moth appeared about ten days and the majority about 15 days after the petals dropped. In 1907 the first moth appeared about the time the petals dropped and the majority a little over two weeks later. Thus in 1907 the earliest eggs deposited would have hatched about ten days after the first spraying, while in 1906 they would not have hatched until three weeks after the first spraying. This will have an important bearing upon the effectiveness of the spray applied to the foliage and would possibly make it more effective one year than another.

Oviposition goes on for about a month, a female laying from 20 to 70 eggs, the average being about 50. The eggs we have observed hatched in 9 or 10 days. It is exceedingly difficult to get the female to oviposit. In 1906 we secured the record of seven moths, but in 1907 we were utterly unable to secure any oviposition tho the same methods were pursued. The eggs are laid on the upper or under surface of the leaves, only a fraction of 1% being laid on the fruit in this locality. An examination of about 700 eggs in the orchard shows that they are on the upper or under side of the leaves, but that on some varieties there are a large number on the upper side and on others more on the under surface. The average distance of 588 eggs from the nearest apples on three trees in 1907 was 6¼ inches, while the average distance from the nearest apples of 744 eggs on six trees during the past two years was nine inches, the average distance of eggs on each tree varying from 2 inches to 28 inches. Eggs are sometimes laid several feet from an apple and indeed are quite commonly laid upon trees with no fruit at all. An examination of a young tree bearing no fruit showed 31 eggs. Apples which are wormy do not seem to be any nearer to eggs than those which are non-wormy. A careful record of the nearest egg to the apples on several trees showed that the eggs were as near to those non-wormy as to those wormy. Very frequently the egg nearest a wormy apple has been 12 inches distant.

The young larvæ feed on the under surface of the leaves mining into the mid ribs and angles of the veins branching from the mid rib and into the axils of the leaves. We have succeeded in rearing a larva in a water sprout and securing the moth from it and several larvæ lived for some time upon tender water sprouts altho we have no evidence

that this occurs in nature. Feeding marks of the larvæ may, however, be readily found upon the foliage. It is evident therefore that the spray upon the foliage must affect the young larvæ. In 1906 eggs just ready to hatch were placed in the calices of apples and were bagged. Seven larvæ averaged 31.7 days in the apples. In 1907, similar experiments showed from 30 to 35 days spent in the apple, but the records were not as accurate. In 1906 no larvæ were observed to transform to pupæ and moths of the second brood during the summer, owing to the fact that the bands were not put on the trees earlier, but in 1907 pupæ were found under the bands, on August 8, the first moth emerging August 12 and moths continuing to emerge to August 23, in all 19 emerging, the most appearing on the former date. There was no increase in the number of larvæ under the bands at this time, but the number of larvæ found under the bands increases gradually from this time on. It is evident, therefore, that the first larvæ to mature transform to the second brood and it seems quite probable from a hasty study of the temperature records, that this is due to the fact that they are able to mature during the hottest part of the summer and that the later larvæ are not subject to so high temperatures. The number transforming and forming the second brood of moths is, however, exceedingly small, certainly not over 1% of the total.

We have been unable to secure very satisfactory data concerning the eggs of the second brood, but careful examination has failed to show them upon the apples. The second brood larvæ hibernate over winter and most of them can be readily detected by the small size and narrow head, but none of those partly grown transform in the spring. Whether a majority of the second brood mature in the fall is an open question. We have evidence that some of them undoubtedly do, but on the other hand we find a large number of the small hibernating larvæ which fail to transform in the spring.

In 1906 an elaborate spraying experiment conducted on 67 trees, there being 5 trees in each of 12 plots and 7 checks, practically failed to give any satisfactory results on account of the method in which the plots were laid out. The plots were arranged as shown in Fig. 3, the check trees being at one side of those sprayed. On either end of the sprayed plots were a few trees which had borne the previous year, but which were not in bearing in 1906. The Baldwin apple has a habit in New England of bearing every other year and all of the experiments here described were on Baldwins. As a result of the spraying, trees near those which had borne the previous year showed very much more injury by the first brood than those at the center of the sprayed plot more distant from them. As no barrier plot had been laid off

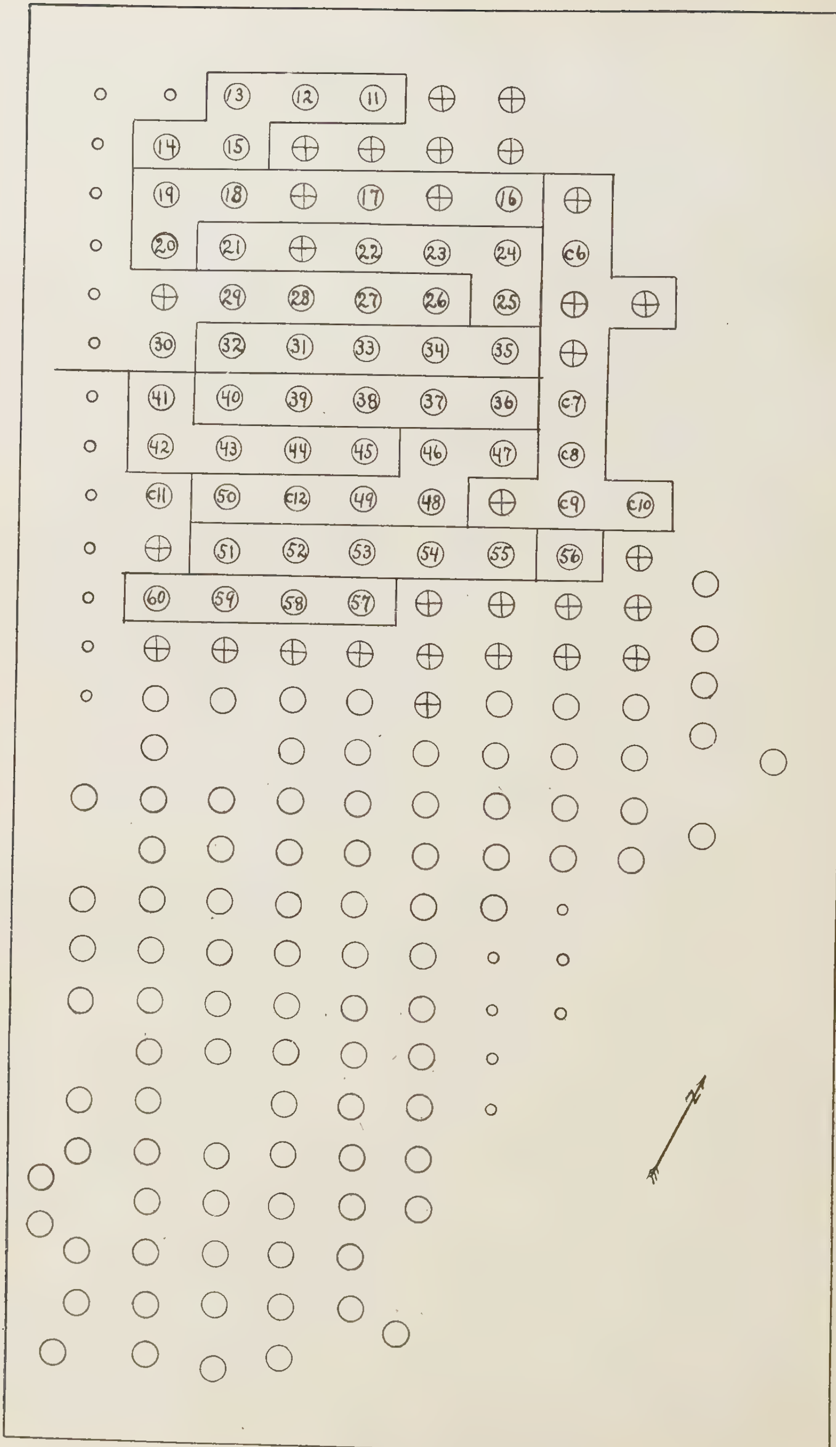

FIG. 3. Caption on opposite page.

between the check trees and the balance of the orchard, which was unsprayed, and the sprayed portion, the moths of the second brood migrated to the sprayed trees and those plots nearest the unsprayed portion showed very little benefit to the second brood, whereas the benefit increased with the distance from the unsprayed trees. The effect of these factors was very noticeable in studying the results. We then happened to remember Dr. Forbes' suggestive paper given before this association a few years ago, in which he showed the way in which the plum curculio migrated from the untreated part of the orchard into the part treated, and the necessity for leaving out of consideration a few rows of trees between the untreated and treated part of the orchard. We therefore decided that in making future experiments we would leave one end of the orchard unsprayed for checks, spray several rows across the orchard next to the checks in the best possible manner, calling this portion of the orchard the barrier plot, and would then lay off our plots at right angles to this barrier plot so that the influence of its effect upon the sprayed plots would be equal in all of them. Happily at this time Prof. Quaintance and the writer met to discuss methods of work upon this subject, and it is to him that I am indebted for the suggestion that we make our plots three rows wide and count only the middle row, thus having 15 trees in each plot, the outer rows of which tend to reduce the influence of one plot on another. Our work this season has shown not only the absolute necessity for such an arrangement, but that it would be wise to go even further and have the plots contain 35 trees each, 5 rows wide and 7 rows long, and count the central five trees so as to better reduce the influence of the neighboring plots. It is of the utmost importance in making an experiment to give any exact results on the codling moth, that the trees be of a uniform size, fruit evenly, and have borne approximately the same the previous year. A few trees scattered thru an orchard which have borne the previous year when the balance of the orchard did not, will seriously affect the results of the work the following season. From careful study of our records, it seems to me that too much importance cannot be placed upon the ground plan of such an experiment, and I cannot but feel that experiments based on individual trees scattered thru an orchard are of little value in trying to determine the amount or nature of the effect of spraying upon the different broods of the codling moth. Furthermore at least five trees must be counted in each

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FIG. 3. Diagram of orchard of Albert DeMerit, Durham, N. H., used in experiments of 1906. Circles represent trees. Circles with crosses are trees which bore in 1905, but bore practically no crop in 1906. Solid lines show boundaries of sprayed plots; remainder of orchard unsprayed.

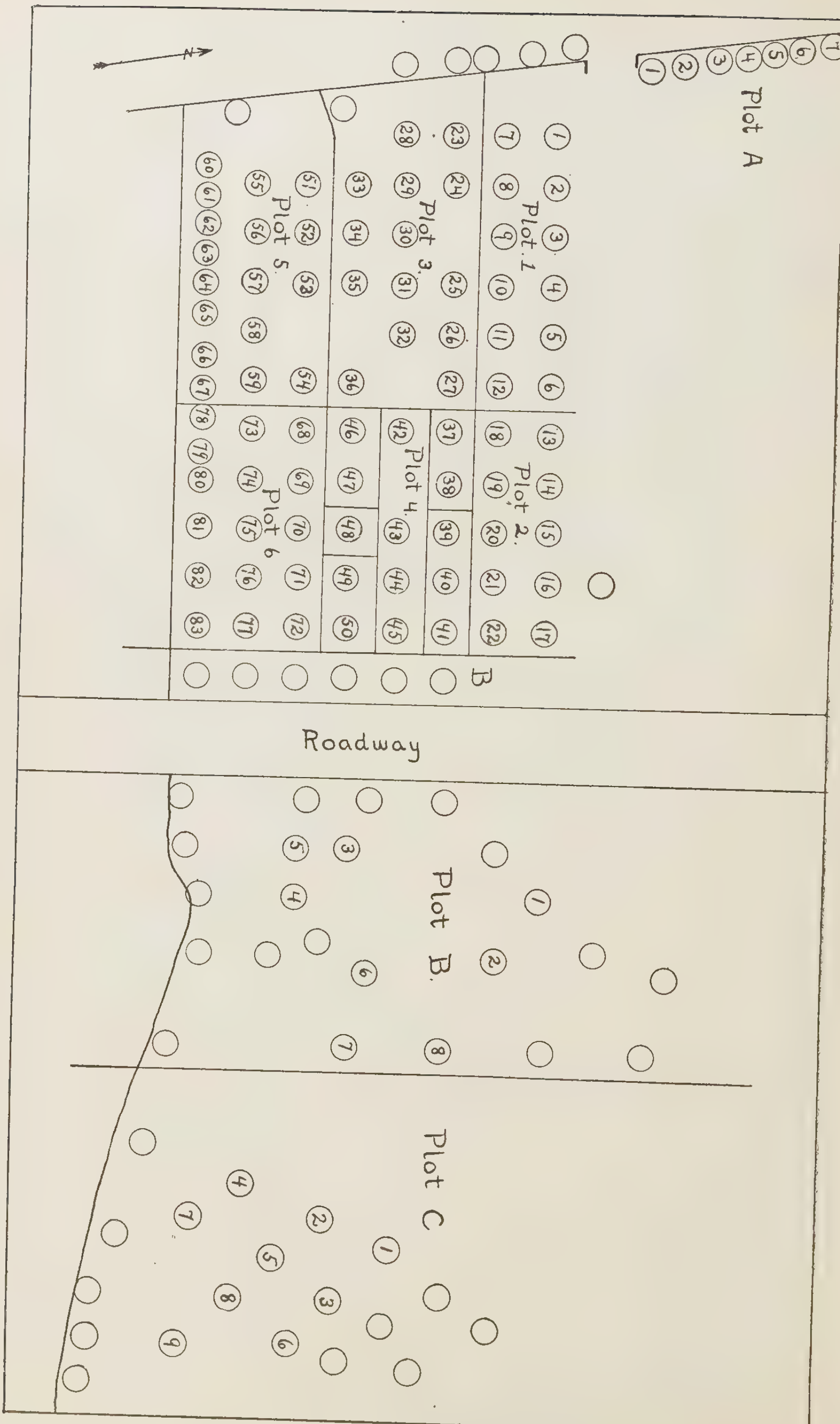

FIG. 4. Caption on opposite page.

plot isolated as already described by surrounding trees similarly treated, and preferably 10 trees should be counted, for it will be found that the records of five individual trees will vary fully as much as the average of one plot and another. All of these factors are therefore of the utmost importance and it becomes a considerable undertaking to make a careful experiment on this subject, the amount of the work depending very largely upon how much competent labor can be secured to make the records. It is needless to say that in our work every dropped and picked fruit has been examined and a record has been made as to whether it was wormy and whether the larva entered the calyx or the side.

It is not my purpose to give any extended discussion of the results of our work of this season, but to briefly report my conclusions. The full data upon which they are based will be published later. Fig. 4 shows the plan of the orchard.

The results of our work have been computed in percentages thruout. This is not the place to discuss our method of computing the results, but suffice it to say that after having compared the number of wormy apples to the number of apples on the tree and the percentage of wormy apples, we find that the percentage wormy is a much more reliable basis for comparison than the number of wormy apples themselves. Our conclusions are based on a study of detailed records of a total of about 400 trees, covering two seasons, and including a count of over 350,000 apples each year.

Plot 1 was given the third spraying (the third spraying being that immediately after the petals fall, the fourth spraying 10 days later and the fifth spraying about three weeks after the petals fall or when the eggs are hatching) with a fine mist. Plot 2 was sprayed at the same time with a Bordeaux nozzle and thoroly drenched, the spray being applied at 100 ℔. pressure. Neither of the plots were sprayed subsequently. This experiment was repeated under similar conditions in another orchard. There was but 2% or 3% difference in the result in both cases, in one orchard the result favoring the drenching and in the other favoring the mist, so that we are forced to the conclusion that there is very little difference in their effectiveness. Careful examination of the calices by Dr. Headlee failed to show any spray lodged beneath the stamens or in the calyx cavity proper, nor did he find any dead larvæ in the calyx cavity proper tho the results achieved by our spraying show very clearly that it was exceedingly effective.

FIG. 4. Diagram of orchard of Gilman Woodman, Durham, N. H., used in experiments of 1907. Plots A, 1, 2, 3, 4, 5, 6, experimental sprayed plots; plot 3, "barrier" plot; plot C, "check" plot, unsprayed.

We are therefore led to doubt whether in New England it is necessary to wait until the stamens have withered in order to force the spray beneath the stamens into the calyx cavity proper, as suggested by Dr. Ball last year.

Plots sprayed with paris green, one-third pound to the barrel and arsenate of lead, two pounds to the barrel, the insecticide being used with Bordeaux mixture, showed practically no difference in their effect. The addition of Bordeaux to arsenate of lead seems to decrease its value very little if any. The arsenate of lead and paris green have now been compared for two years, and where a sufficient amount of either is used, so that the percentage of arsenic is the same, one seems to be about as effective as the other.

The proportion of the larvæ entering the calyx has always been a matter of interest, as bearing directly upon the effectiveness of spraying into the calyx. We find for the first brood that the percentage of larvæ entering the calyx on unsprayed trees varies from 67% to 77%, in four orchards averaging 73%. For the second brood at Durham the proportion was 67% and 78% on unsprayed trees, averaging 74.5%, or practically the same as for the first brood, but at Pittsfield and Deerfield, back from the coast, and on hills, the second brood is smaller, as will be shown later, and but 22% to 24.6% of the second brood enter the calyx on unsprayed trees.

We have endeavored this year to determine the exact effect of the spray upon the larvæ, as to whether they are killed in the calyx, on the foliage, or on the surface of the apple, for both the first and second brood. Four trees were sprayed immediately after the blossoms fell with a hand atomizer, the spray being placed directly in the calyx without hitting the foliage. In all of these experiments the spray was arsenate of lead, two pounds to the barrel, without Bordeaux unless otherwise indicated. These four trees were not sprayed later. They gave a benefit of 59%, based on the percentage of the total fruit, which was wormy by the first brood, against a benefit of 91% on the plots which were sprayed in the ordinary manner so that the foliage was covered, indicating that about one-third of the benefit was due to the spray on the foliage.

One tree was not sprayed when the petals fell, but about three weeks later when the eggs were hatching. All of the apples on it were covered with paper bags and the tree was then thoroly sprayed, thus covering the foliage, but not the apples. The bags were then removed. It was contemplated to treat several trees in this manner, but as it was a week's labor to bag one tree, it was impossible. This spraying of the foliage gave only 18% benefit, based upon the percentage of the

total fruit wormy by the first brood, with 10% benefit due to less injury by worms entering the side of the apple, and the balance of 8% due to benefit by fewer worms entering the calyx.

One plot was given the fifth spraying (that is three weeks after the petals dropped, or as the eggs were hatching) in the ordinary manner, in this the apples being sprayed as well as the foliage, but not having been previously sprayed, no poison was deposited in the calyx. This plot gave a benefit of 25%, based on the percentage of the total fruit wormy by the first brood, with a benefit of 15.7% due to fewer worms entering the calyx, and 9% due to fewer worms entering the side. If the benefit derived from spraying the foliage only upon the tree, which was bagged, be subtracted from that secured on the plot where both the foliage and apples were sprayed with the fifth spraying, we get the benefit due to the spray on the apples as regards the first brood, and find that it is about one-fourth of the value of this fifth spraying, and consists entirely of a benefit due to fewer worms entering the calyx or about 7%. If we divide the value of the fifth spray between the benefit derived from fewer worms entering the calyx and fewer worms entering the side, according to these proportions, we find that 9% out of the 25% is due to fewer worms entering the calyx and 15.7% due to fewer worms entering the side, or about two-fifths of the benefit is due to the calyx and three-fifths to the side.

But only 29% of wormy fruit are due to the work of the first brood on the unsprayed trees. When the benefit done by the control of the first brood alone is measured in terms of percentage of the benefit for the whole season, we find that only 27.5% out of 96% is due to the direct benefit on the first brood, where sprays III, IV and V were given. As a matter of fact the benefit of these sprayings thru their effect on the first brood is much greater than this and can only be shown after we have considered their effect on the second brood.

The addition of spray V did not seem to materially increase the benefit to the first brood when given after spray III, but the addition of spray IV and V to III show a very slight benefit over III and V.

In order to determine the true benefit of the effect of sprays on the first brood, we must find their effect on the second brood and by subtracting it from the total effect for the season we secure the real benefit due to the influence on the first brood, for it is evident that by reducing the numbers of the first brood there will be fewer of the second brood, and the apparent total benefit to the second brood is therefore really due to the effect of the lessened numbers due to the killing of the first brood, as well as to the direct effect of the spray upon the second brood.

The proportion of apples injured by the first and second brood varies with the locality and seemingly according to the percentage which transform to the second brood. Thus, at Durham in 1907, 29% of the wormy apples were injured by the first brood and 71% by the second, and in 1906 about 40% were injured by the first brood and about 60% by the second on unsprayed trees, while at Deerfield, 15 miles distant in the hills, in 1907, 70% were injured by the first brood and 30% by the second brood, and at Pittsfield, 30 miles distant, 48% were injured by the first brood and 52% by the second brood on unsprayed trees.

The effectiveness of the spraying seems to vary somewhat from season to season, and it seems quite possible that if heavy rains follow sprays III and IV that their effect upon the larvæ feeding upon the foliage would be lessened, whereas the benefit due to spray V would not be so much affected as if it is applied just as the eggs are hatching. Those plots sprayed with only the third spraying show but little total benefit to the second brood, averaging 12%, while those sprayed with the third and fifth sprayings show little or no total benefit, due probably to the fact that the destruction of the first brood was so complete that it is very difficult to determine any additional influence, unmistakably due to the effect of the spray on the second brood. But an addition of spray VI (spray VI being applied when the second brood of eggs are laid) gave 70% of the possible benefit due to the direct effect of the spray on the second brood. Spray IV gave a total of 22% of possible benefit, and spray V from 22% to 79% of possible benefit, with an average of 60% of the possible benefit due to the direct effect of the spray on the second brood, this being 22% benefit in terms of the benefit for the whole season, which was but 58%, or in other words 37% of the total benefit of the year was due to the direct effect of spray V upon the second brood.

Analyzing this benefit to the second brood, as to its effect upon the worms entering the calyx and side, we find that in the plot treated with spray III the benefit to the second brood was due entirely to those entering the calyx, giving 46% benefit to the calyx, but showing a loss of 14% or 15% in those entering the side, thus indicating that some of the spray lodged in the calyx affects the second brood which enter the calyx, but that the third spray has no effect on those entering the side, or in other words, kills very few or none of the second brood upon the foliage. When spray V or IV and V are added to spray III, from 75% to 80% benefit to the calyx is secured, but no benefit is secured to the side, but with the addition of spray V and VI (VI being applied for the second brood eggs), 95% benefit to the

calyx and 25% benefit to the side for the second brood is secured, showing that spray VI kills mostly by its effect on larvæ feeding on the foliage. That no benefit is secured in lessening the number of worms of the second brood entering the side when spray V is added to spray III as would be expected from the additional spray put on the foliage, is doubtless due to the very effective work on the first brood of sprays III and V, leaving such a small percentage to be killed by the direct effect of the spray on the second brood as to be undemonstrable.

Spray V alone gave an average of 66% benefit thru lessening the worms of the second brood entering the calyx, and was the only one showing any benefit by lessening the worms of the second brood entering the side, giving 62% benefit to the side, the benefit to the side and calyx being practically equal tho twice as many worms entered the calyx as the side in the checks, thus showing that 66% of the second brood which entered the calyx are killed by spray on the foliage, as well as 62% of those which would enter the side. Thus about 60% of the benefit possible to secure from the direct effect of the spray upon the second brood is secured by the fifth spray alone applied to the foliage, and this spray would therefore be of importance in an orchard adjoining an unsprayed orchard near enough for the second brood of moths to spread to it. This is shown by our barrier plot, "B", which showed a total of 20% of the possible benefit due to direct effect on the second brood, while plot 3 surrounded by sprayed trees showed no such benefit. Furthermore the tree on which the apples were bagged and only the foliage sprayed with the fifth spraying, shows as much total benefit to the second brood as those in which the apples also were sprayed at the fifth spraying, again showing that most of the benefit due to the direct effect on the second brood is from the effect of the spray on the foliage.

Considering the part of the total benefit of the season which is due to the spray affecting the first brood as against the second brood, we find that in case of spray III, and III and V, that 88% to 100% of the total benefit was due to the effect on the first brood and thru it to the second brood, whereas in spray V only from 36% to 86% (average 64%) was due to the effect on the first brood, and from 14% to 64% of the total benefit was due to its effect on the second brood.

Thus in New England the first brood may be controlled by thoro spraying at the time the petals drop, spray III, but if there be danger of the second brood migrating into the orchard, spray V should always be added, as it will sufficiently control the second brood, tho if an infestation be serious in neighboring orchards, the sixth spraying will

sometimes pay in addition. In New England the fifth spray should always be used with Bordeaux mixture for the control of the fruit spot irrespective of the codling moth, so that the addition of arsenate of lead will cost but little and will render the control of the codling moth much more certain. Early in August it is well to spray for the brown-tail moth and other leaf-eating caterpillars, which have been quite numerous in New England orchards for the last few years, and the sixth spraying will therefore control them and the second brood at the same time.

Considering the total benefits for the season, it is found that spraying the calyx only may give a benefit of 62%, while spraying the foliage only may benefit 52% (tho the influence of adjoining treated plots increased the benefit by decreasing the second brood of these plots, so that really the benefit is less), but where foliage and apples are sprayed at the fifth spraying, a benefit of 74% may sometimes be secured, tho here again neighboring plots have increased this apparent benefit.

Whether the spray on the foliage or the spray on the calyx kills the more larvæ, it is impossible to determine definitely from our results, which would seem to indicate that where spray V is given there are about two chances that a larva will be killed on the foliage to three that it will die in the calyx. Giving our figures as conservative an interpretation as possible, it would appear that of the total benefit for the whole season, at least one-third and possibly one-half is due to the spray on the foliage, and the balance to that deposited in the calyx. Heretofore only the spraying of the calyx has been emphasized, but in all cases where records have shown a separation of the apples wormy in the calyx and in the side, such as those given by Dr. Ball at our last meeting, a decided benefit has been shown by reducing the number of larvæ entering the side, and if this be due to the spray deposited on the foliage, how much of the apparent benefit from the decreased number of worms entering the calyx is really due to their being killed on the foliage?

Mr. Taft stated that in Michigan it is necessary to apply an extra spraying to control the second brood of this insect.

Mr. Fletcher asked if it is not probable that New Hampshire and Michigan are in two different faunal areas, as far as the codling moth is concerned.

Mr. Taylor was positive that the results given in this paper would not apply in Colorado. He recalled experiments and observations which had extended over fully five hundred acres of orchards where

the first generation was practically controlled. Possibly the larvæ feed on the leaves to a greater extent in New Hampshire than in Colorado. In Grand Valley in Colorado in 1907, the entomologist kept track of the climatic conditions and the growers were notified by circulars, telephone or telegraph, so that the spraying was done at exactly the right time. The results that were secured in Colorado agreed in general with those of Dr. Ball in Utah.

Mr. Headlee stated that the apple crop was an absolute failure this year in Kansas and asked if there would be codling moths next year. In reply Mr. Quaintance said that the moth was supposed to have been exterminated in a small valley in California in this manner. Professor Garcia is now conducting an experiment of this kind in New Mexico.

Mr. J. B. Smith called attention to the fact that the pupae of Lepidopterous insects that are normally single brooded sometimes pass the winter in that stage. If this was occasionally the case with the codling moth, the species might be carried over in this way.

Mr. Taylor mentioned the entire absence of codling moth eggs in orchards that were barren in 1907, though badly infested in 1906, when a full crop of fruit was borne.

Mr. Fletcher remarked that he had once carried this insect over the second winter in the pupa form, but the specimen was kept in his office.

Mr. Quaintance presented the following paper:

NOTES ON THE LESSER APPLE WORM, ENARMONIA PRUNIVORA WALSH

By A. L. Quaintance, *Washington, D. C.*

(Withdrawn for publication elsewhere.)

Mr. Sanderson asked if the work of this insect can be distinguished from that of the codling moth larva. Mr. Quaintance replied that the larvæ work to a considerable extent in the calyx basin, boring holes into the flesh from one fourth to one-half an inch deep around the calyx and eating out the flesh under the skin in the calyx cavity; and also on the sides of the fruit, especially where touched by another apple or a leaf. Except as the fruit is nearly ripe, larvæ rarely penetrate to the seeds, as is done by the codling moth larvæ. The lesser apple worm, when full grown, is about the size of a half grown codling moth larva, but is somewhat fusiform in shape and is flesh-colored, or pinkish. On the caudal portion of the anal segment there is a small

brownish comb-like structure composed of seven teeth and distinguishable with a hand lens.

Mr. Bruner stated that he had found an insect which he had supposed to be this species of *Enarmonia* on wild roses.

A paper was presented, entitled:

EGG LAYING OF EMPOASCA MALI

By F. L. Washburn, *St. Anthony Park, Minn.*

In the twenty-first annual report of the state entomologist of Illinois (1900), Professor Forbes states that what were then supposed to be the eggs of the above species were found in slight swellings on the green twigs and on the mid-rib and leaf stem of the apple. This supposition regarding the summer egg must have been correct, for we find young larvæ so small and helpless on the mid-rib during the summer as to force one to conclude that its place of hatching must have been near by. Nevertheless, the truthfulness of the supposition was not determined at that time, and so far as we are able to discover, there has been, up to this date, no absolute confirmation of this belief, nor has there been, to the best of our knowledge, at any time hitherto, any accurate observations on the location of the fall-laid eggs, the eggs from which come the first spring brood.

Fig. 5. Blisters containing eggs of *Empoasca mali*, much enlarged (original).

Young apple trees which had been infested with leaf hoppers in the summer of 1906 were dug in October of the same year and planted in the insectary at the Minnesota Experiment Station. The heat was not turned on in the room until quite late in the winter. The leafing out of the trees was shortly followed by the appearance of *Empoasca* larvæ, but in spite of careful searching, eggs were not discovered. Later in the spring, however, when hoppers appeared outside, Mr. Ainslie, at that time an assistant in the department, found, April 23d, on a young apple tree back of the insectary, several pouches or pockets in the bark about 2 mm. long and 1 mm. wide at their widest portion. The mouth of each pouch was about 1 mm. long. This opening appeared to be closed with dirt or woody growth. One was dissected and found to contain an egg which almost filled the pouch, its small end toward the opening. Mr. Ainslie describes the egg as being white

with a membranous and semi-opaque shell, and 1.5 mm. long. He says in his report: "The cavity was lined with a reddish, glossy material, which seemed to be a thin skin, separable from the woody tissues. The sap was just beginning to run and the tissues were full of it."

Of course, it yet remained to be proven that the above egg was that of *Empoasca.* No more eggs were found until May 24th, when Mr. R. L. Webster, in charge of the insectary and a part of the field work for the department during the summer, found them quite numerous in three-year old apple stock in a southern Minnesota nursery. He reports these eggs as being somewhat smaller than those found at St. Anthony Park, measuring .4 and .75 mm. Mr. Ainslee's description applies so well to the later found eggs that there is but little if any doubt of their being those of the same species. All these "blisters" or pouches containing eggs were found on old wood in the upper part of the trunk, and none on the small twigs, and their general shape varied from that of a fresh water mussel or clam shell to almost cylindrical.

FIG. 6. Nymph of *Empoasca mali* within the pouch, the covering epidermis being turned back, much enlarged (original).

A small tree showing a number of these blisters was taken into the insectary, and there a young *Empoasca* was observed in the act of emerging. This specimen died before becoming free from the blister. A sketch was made at the time by our artist, showing the bark cut back and the body of the larva below.

We cannot speak of the location of the summer egg with as much certainty as we can of the winter egg, although putting the evidence in our possession with that of others, we are inclined to the belief that the petiole and mid-rib, as well as the leaf itself, may be the places chosen for oviposition on the apple by the females of the summer generations, for Ainslie found on June 25th an enlargement on a petiole which contained the remnant of an egg shell, and on September 4th Webster found a swelling in a leaf similar to that which characterized the presence of the winter eggs. Only one was found. Webster describes it as 5 mm. long, slightly brown, with a slit in one end.

On September 19th in a large nursery, Mr. Ainslie examined a number of one year old apple trees. These trees were almost hidden in a

growth of buckwheat planted for winter protection. The plot had been infested with leaf hoppers earlier in the season, and a few were doubt of their being those of the same species.

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The buckwheat growing amongst these trees was also examined, and two similar discolored swellings found on petioles. At this date there were very few *Empoasca* on the trees, but they were numerous on the buckwheat. Dissection of some of this material on November 9, preserved in alcohol since September 19, and not in very good shape, disclosed nothing of which we can speak definitely.

Insectary records of the stages of *Empoasca* show a record of from nineteen to twenty-five days as nymphs, and five nymphal stages between egg and adult. It was practically impossible for us to determine the length of each instar exactly, but it may be safely said that the first brood nymphs have longer instars than those in the following broods. The average lengths of individuals in the successive nymphal stages are as follows: First stage, .8mm.; second, 1.3 mm.; third, 1.7 mm.; fourth, 2.1 mm.; fifth, 2.4 mm., and the adult 3.1 mm.

Mr. Webster reports observing these hoppers hopping in the last nymphal stage, in several instances leaping a distance of over a foot.

These observations were made in the field at a time when the hoppers were disturbed. From this observation it would seem that while they always walk in the first, second, third and fourth nymphal stages, they may either walk or hop in the fifth.

Evening Session, Saturday, December 28, 1907

The final session of the meeting was held in the parlors of the Windsor-Clifton Hotel at 8 p. m.

The following papers were presented, the discussion being postponed until the close of the last paper:

NOTES ON SOME INSECTS OF THE SEASON

By HERBERT OSBORN, *Columbus, Ohio.*

While there has been no widespread devastation from insects during the past season in Ohio, there have been several minor outbreaks covering certain localities, and some of these it seems worth while to put on record. Comparison of these with occurrences of these species or of other forms during other seasons has a distinct interest.

In the northern part of the state there was a quite noticeable amount of injury from the bollworm, *Heliothis obsoleta.* This was particularly serious in gardens and on the truck farms in the vicinity of Sandusky, and in addition to the ordinary attacks upon corn and tomatoes, attacks were made upon nearly all kinds of garden crops. Very noticeable injury occurred upon beans, cabbages and various other crops that have not been so commonly attacked.

In the vicinity of Columbus there was considerable damage by the walnut caterpillar, *Datana angusii,* many trees in Columbus and vicinity being stripped completely bare of foliage, and clusters of *Datana* occurring, sometimes representing a half dozen or more colonies upon a single tree.

Another species that was unusually injurious in the central part of the state and I think over a considerable area is the white-marked tussock moth, *Hemerocampa leucostigma.* These occurred in immense numbers upon maple trees and also on other kinds of shade trees, and the egg clusters on the cocoons have been a very conspicuous object during autumn and the present winter.

ENTOMOLOGICAL NOTES FROM MARYLAND

By G. P. WELDEN, *College Park, Md.*

(Read by T. B. SYMONS.)

Scale insects, though still holding a place of importance in the state, are no longer dreaded, as formerly. A large percentage of the fruit

growers are successfully controlling the ravages of these pests, and it is only a question of time until a few negligent people in isolated localities will hear of the good work being accomplished and will fall into line with the host of successful combatants. Time will bring about a wide enough dissemination of knowledge, so that scale will be practically eliminated from all orchards where it occurs through the use of a good spraying mixture, properly applied.

Aspidiotus perniciosus is without doubt the most generally distributed scale pest occurring in the state. Others that deserve more than passing mention are *Eulecanium nigrofasciatum, Chionaspis furfura, Lepidosaphes ulmi* and *Chrysomphalus tenebricosus.*

Chrysomphalus tenebricosus. The past season was especially favorable to the increase of this species, and in many parts of the state the native maple trees suffered severely from its attack. The natural parasites which usually occur in large enough numbers to keep it in check seemed in many places to be exceedingly scarce, which fact no doubt accounts for the severe damage done by the scale. From the fact that no trees in badly infested localities were found to have been killed outright, it is probable that the multiplicity of the pest the past season was unusual. Many trees were literally coated with the scale and cannot possibly survive another season's attack, should it continue to breed in such large numbers, unless the owners of trees come to their aid with the lime and sulphur wash or some other good insecticide. Though no trees were found killed by the pest, the numerous dead branches told of its ravages and foretold the destruction of the trees.

The distribution of the pest seems to be quite general throughout the state. It was found on red maples *(Acer rubrum)* in Cumberland but not in destructive numbers. The worst infested section lies east of the bay, and of the counties visited, Talbott, Worcester and Somerset have the greatest degree of infestation.

No insecticides have been tested for its control, but from the nature of the scale and its attack we would feel safe in recommending the lime and sulphur wash as a good remedy.

Lepidosaphes ulmi. This pest and *C. tenebricosus* are the two most important enemies of maple trees in Maryland. The oyster shell scale has been so frequent a subject for discussion that we do not wish to go into any lengthy history of its occurrence and ravages within the state. We do wish, however, to mention one thing that came to our notice upon investigating its injury in different parts of the state the past summer, and that is the seeming immunity of Norway maples to its attack. Only in one case did we find *Lepidosaphes ulmi* on Norway

maples and that was on a few small trees in a nursery row. This immunity, or probably we might better say resistance, was particularly noticeable in Cumberland, where the scale was exceedingly bad on poplars and native maples. Apparently none of them were absolutely free from it, yet Norway maples, which are very plentiful in the city and growing alongside of them, were examined in large numbers, and not in a single case did we find one infested.

Further investigations might prove the fallacy of the above statements, but we think it probable that there is a resistance here at least as great as that of the Kieffer pear to *Aspidiotus perniciosus*.

Monocesta coryli. Among the insects of less common occurrence which became a pest in at least one locality in the state the past season, may be mentioned *Monocesta coryli*, the greater elm leaf beetle. This beetle was found in large numbers last July in the vicinity of Keedysville. Its attack seemed to be confined to the native wild elms, which it was defoliating so badly that it would no doubt be a serious pest, should it continue to appear in future seasons as it did the past.

We were unable to find any literature indicating its presence in the state prior to the past season. One specimen in the department collection, however, bears a Sharpsburg label, dated July 21, '98. No notes could be found which would indicate that it had occurred there in large numbers at that time. As the present year they were found within a couple of miles of Sharpsburg, it seems reasonable to believe that they have been in the vicinity for a number of years, but probably in less numbers. In the Mississippi Station report for 1895, Mr. H. E. Weed mentions its presence in that state and suggests for it the name of Greater Elm Leaf Beetle to distinguish it from the more common smaller species of elm leaf beetle, *Galerucella luteola*.

Owing to the fact that *Monocesta coryli* is of uncommon occurrence and is not a familiar insect to many workers in entomology, we thought best to publish herewith a short general description of same.

The full-grown adult insect is about one half inch long from the anterior margin of head to the posterior margin of elytra. Head, legs and abdomen are a light yellow color. Anterior one third of the elytra and a trifle more than the posterior one third, are of a deep green color shading on blue, with a beautiful metallic luster. A wide band of yellow crosses the elytra between the green markings. Elytra are long, projecting well back of the tip of the abdomen, also well below the sides. There is much in the general appearance of this insect to indicate that it is a tropical species which has migrated north, and has become acclimated in this latitude.

No remedies were tried for its control, neither were we able to

learn anything of its life history, as a number placed in a breeding cage failed to breed in confinement.

Monoptilota nubilella. On July 16 a number of lima bean plants, upon the stems of which were numerous galls, were sent to the department by Mr. Oscar L. Moore of Salisbury. They varied in length from ½ inch to 1½ inches. An opening had been made by the larvæ in one end. Upon cutting into one of these galls, a beautiful bluish green larva was found to be responsible for their formation and the subsequent injury to the plants. The larva is a striking one in appearance, because of its uncommon metallic blue reflections. Several of the adults emerged from the galls and were identified as *Monoptilota nubilella.* A detailed account of this insect by Doctor Chittenden of the Bureau of Entomology may be found in Bulletin 23, new series, U. S. Department of Agriculture.

This pest was first found in the state in 1899 and has no doubt been responsible for more or less injury to lima bean plants since that time. No serious complaints of its injury came to the office, but should it become plentiful, it would no doubt be a hard pest to combat. The only means of control suggesting itself would be the removal of the galls from infested plants.

Thyridopteryx ephemeraeformis. This species of bag worm was responsible for a large amount of injury to fruit and shade trees the past season. Numerous inquiries as to its name and habits were received from widely separated localities in the state, showing that its occurrence was general. In many different places the writer saw evergreen trees, mostly arbor vitae in hedges, killed by it. Its attack was by no means confined to evergreens, however, for it was found on locust, blackberry, rose, maple, apple, plum and cherry. Young fruit trees seemed especially subject to its attack and trees in several young orchards visited were badly stripped.

Other pests of the season which were responsible for more or less damage but deserve no more than passing mention were: Army worm *(Heliophila unipuncta)*, old-fashioned potato beetle *(Epicauta vittata)*, bean leaf beetle *(Ceratoma trifurcata)*, striped cucumber beetle *(Diabrotica vittata)*, stalk borer *(Hydroecia nitela)*, red humped apple worm *(Schizura concinna)*, yellow-necked caterpillar *(Datana ministra)*, and corn bill bugs *(Sphenophorus sp.)*.

ENTOMOLOGICAL NOTES FOR 1907

By E. P. Felt, *Albany, N. Y.*

The climatic conditions of 1907 departed widely from those of normal years, and as a result the development of animal and plant life

was exceptionally late. Warm weather finally came on very rapidly and all vegetation grew at such a rate that insects appeared unable to inflict material damage in many cases, consequently there has been a remarkable dearth of injurious outbreaks, particularly in the early part of the year and presumably largely due to this cause.

The San José scale, *Aspidiotus perniciosus* Comst., continues to be one of our most serious insect pests. It is gratifying to state that a number of our more progressive fruit growers at least have learned to control this insect in a very satisfactory manner. There is a strong tendency on the part of many to adhere to a lime-sulphur wash rather than to make extensive treatments with mineral oils or preparations of the same, despite the fact that some of these last named materials have been pushed vigorously by certain commercial agencies. The backward season had a very pronounced effect on the development of the grape root worm, *Fidia viticida* Walsh. Normally, this species transforms to the pupa from about June 1st to the 20th, the full grown larvæ being near the surface some days at least before pupation occurs. Observations made July 10 resulted in finding only a few recently transformed pupæ on light soil, whereas under normal conditions the beetles would have appeared two or three weeks earlier. There has been on the whole a distinct improvement in conditions over those obtaining a few years past, though it should be borne in mind that there is always danger of serious injury by this pest in restricted areas. The apple leaf folder, *Ancylus nubeculana* Clem. is normally rare in New York state orchards. It was so abundant in Cattaraugus County last September as to lead to the report that it was doing considerable damage to apple trees in that vicinity.

Our attention was called the last of July to the unusual abundance of a comparatively unknown form, namely, *Epizeuxis denticularis* Harvey. This species was so abundant at Palenville, Greene County, N. Y., that hundreds were observed upon the walls of the kitchen and they were also very numerous about the barn and other out-buildings. It is very probable, considering that the larva of the closely related *E. lubricalis* Geyer feeds upon grass, that the caterpillar of this species may have similar habits, though it is possible that it may subsist upon dried vegetation, as has been recorded of *E. aemula* Hübn. The evidence at hand would seem to favor the latter conclusion, as the moths were very abundant in buildings where there was presumably a goodly supply of dried provender upon which the caterpillars could subsist. Should such prove to be the case, this species should be classed with the much better known clover-hay worm, *Hypsopygia costalis* Fab. as a species liable to injure stored hay.

Several shade tree pests have excited considerable interest because of their serious depredations. The white marked tussock moth, *Hemerocampa leucostigma* Sm. & Abb., defoliated trees in a number of cities and villages in New York state, and would undoubtedly have caused more injury had it not been checked by local work in various communities. The elm leaf beetle, *Galerucella luteola* Müll., was exceedingly destructive to the elms of Albany and Troy in 1906. An extended injury in 1907 was prevented only by thorough and extensive spraying. The sugar maple borer, *Plagionotus speciosus* Say must be ranked as one of our most injurious species, as observations show that it is seriously injuring young maples here and there throughout the state. It is abundant enough in some localities to threaten the existence of long rows of nice young trees.

Forest insects have occasioned considerable anxiety in certain parts of the state. The green striped maple worm, *Anisota rubicunda* Fabr., was very abundant over several square miles of forest land in southern Rensselaer County, defoliating tracts of sugar maples acres in extent. The operations of this insect were first observed in 1906, at which time approximately eight or ten acres were badly injured. The past season these trees were entirely stripped of foliage, and maples here and there over a considerable area lost a goodly proportion of their leaves. This species was assisted in its destructive work by what we have designated as the antlered maple caterpillar, *Heterocampa gutivitta* Walk., a species which was evidently very numerous, judging from the specimens submitted for examination. Certain of the beech forests in the Catskills suffered from an outbreak by the snow-white linden moth, *Ennomos subsignarius* Hübn., the caterpillars being numerous enough to strip most of the trees over an area about a mile long and ranging from one eighth to one fourth of a mile in width. An unusual injury was the destruction of some 2,500 to 3,000 one and two year old white and Scotch pine seedlings in the state nurseries located in the Adirondacks. The injury, so far as observations could be determined, was caused entirely by white grubs, presumably those of our common northern form, *Lachnosterna fusca* Fröhl.

A BRIEF SUMMARY OF THE MORE IMPORTANT INJURIOUS INSECTS OF LOUISIANA

By Wilmon Newell and Arthur H. Rosenfeld, *Baton Rouge, La.*

Louisiana, with her combination of semi-tropical and temperate climates and plants and the consequent variety of natural enemies of the latter, is of great interest entomologically. For many years ships from foreign countries have been entering the port of New Orleans,

bringing with them much of the flora and fauna of tropical and other countries. Until very recently nothing has been done to prevent the dissemination of all kinds of new and dangerous insects to all parts of the state from New Orleans as the main entrance point. As a result the insect enemies of plants and animals in the Pelican state are legion.

The authors have not attempted in this paper to catalogue all of the injurious insects of the state, but as there has been no report of this kind presented from Louisiana for several years, they have thought it well to place on record a brief account of the most injurious insects which have come to their attention during the past three years.

The economic importance of a species is determined by the value of the plants or animals which it infests. The codling moth, for example, a most important pest in the North, is of no importance in Louisiana, simply because the apple crop is not of commercial size. The injurious insects of Louisiana therefore take a different rank, in the order of their importance, than in most other states. It may be well to mention that the cotton and sugar-cane crops of Louisiana far excel in value any of her other products, each of these crops being worth in the neighborhood of $26,000,000 annually. The yearbook of the Department of Agriculture for 1905 gives the value of several of Louisiana's other important crops as follows:

Corn	$11,905,064
Rice	5,511,730
Hay	568,353
Potatoes	532,663
Oats	199,548

Besides the above Louisiana has important nursery and orchard interests and the value of her output of live stock is by no means small.

Cotton Insects

Louisiana's cotton pest of greatest importance is, of course, the boll weevil, *Anthonomus grandis* Boh. The state has an area of about 45,000 square miles, of which approximately three fourths, or 34,000 square miles, is embraced in the cotton-growing area. Of this, about 29,000 squares miles are now infested. About 15,000 square miles are heavily infested, while in the remaining 14,000 the infestation is still slight. Enough is already on record regarding this insect to render further mention unnecessary.

The boll worm, *Heliothis obsoleta* Fab., has varied in its attacks with the seasons. The past year the boll worm ravages have been particularly severe, and much of the injury by this pest was ascribed by planters to the boll weevil.

The attacks of the cotton caterpillar, *Alabama argillacea* Hübn., the cotton aphis, *Aphis gossypii* Glover, and the cotton square-borer, *Uranotes melinus* Hübn., have been generally variable, but seldom severe. Late in the season the caterpillar is regarded as a friend of the planter, as, by its destruction of the green, succulent growth of the cotton plants, it destroys the food supply of the boll weevil, thus lengthening the period during which the latter must survive without food.

The cowpea pod weevil, *Chalcodermus aeneus* Boh., is frequently and generally reported from all parts of the state, being often mistaken for the boll weevil. Early in the spring, before the cowpeas are up, these weevils assemble upon the young cotton and often do considerable damage by puncturing the leaf and terminal stems, causing their death.

Three other cotton insects which are from time to time locally injurious are the garden web-worm, *Loxostege similalis* Guen., the differential locust, *Melanoplus differentialis* Thos. and a leaf-footed plant-bug, *Leptoglossus phyllopus* Linn.

Sugar Cane Insects

The principal insect enemies of sugar cane are the cane borer, *Diatraea saccharalis* Fab., which also attacks corn, and the mealy bug known in Louisiana as the "poo-a-pouche," lately identified by Mr. J. G. Sanders as *Pseudococcus calceolariae* Mask. This insect is of interest because it seems to be colonized by the Argentine ant, *Iridomyrmex humilis* Mayr. So far as known, it is at present limited to the territory extending from New Orleans to the Gulf of Mexico, the infested area embracing about 1,500 square miles. The ant, however, is well distributed over the southern part of the state, and the appearance of the poo-a-pouche in other localities may be expected at any time.

Insects Injurious to Cereal and Forage Crops

Corn is attacked principally by the bollworm and caneborer, already mentioned, and the southern corn rootworm, *Diabrotica 12-punctata* Oliv., the latter being particularly injurious on alluvial lands.

The principal rice insects are the rice weevil, *Calandra oryzœ* Linn., and the rice maggot, *Lissorhoptrus simplex* Say.

Outbreaks of the fall armyworm, *Laphygma frugiperda* Sm. & Abb., have been occasionally reported in scattered localities. In July of the present year, Mr. W. C. Harris of Alexandria, La., reported

that they had eaten up 110 acres of alfalfa in three days and were also eating his cotton plants.

The present year has also brought the destructive pea aphis to the attention of the writers for the first time. In April complaints were received from St. Bernard Parish that the cowpea and onion crops were entirely destroyed by insects. The aphis responsible for destruction of the peas was identified by Prof. E. D. Sanderson as *Nectarophora pisi* Kalt., while the onion enemy proved to be the onion thrips, *Thrips tabaci* Lind.

The Colorado potato beetle, *Leptinotarsa decimlineata* Say, is not generally injurious in this state, although it sometimes does damage locally. It is more important in the northern part of the state than in the southern; in fact, is seldom seen in the coast region.

Sweet potato culture in southern Louisiana has been made almost impossible by the sweet potato borer, *Cylas formicarius* Fab., which is rapidly becoming one of our most injurious insects. The habits of this pest make it a very difficult one to control in the field, although fumigation seems fairly effective in protecting the stored tubers.

The cabbage enemies are the usual Harlequin cabbagebug, *Murgantia histrionica* Hahn., and the imported cabbageworm, *Pontia rapae* Sch.

Insects Affecting Deciduous Fruits

Among the Coccids which are more or less injurious to deciduous fruit trees and nursery stock are the San José scale, *Aspidiotus perniciosus* Comst., Putnam's scale, *Aspidiotus ancylus* Putn., cherry scale, *A. forbesi* Johnson, English walnut scale, *A. junglans-regiae* Comst., European fruit scale, *A. ostreaeformis* Curt., and the terrapin scale, *Eulecanium nigrofasciatum* Perg. With the exception of *perniciosus,* the species of *Aspidiotus* are important principally on account of their occurrence on nursery stock, although a few orchard trees have been found very badly infested with *A. forbesi.*

A. perniciosus is widely scattered over the state, being established in practically every section where any large number of peach trees are grown. On account of the long breeding season in Louisiana, this insect multiplies much more rapidly than in the northern states. Young larvæ have been observed in every month of the year.

Another Coccid which has been injurious in a few instances in the southern part of the state is the West Indian peach-scale, *Aulacaspis pentagona* Targ. The state nursery regulations require that this insect be dealt with in the same manner as San José scale, when found in or near a nursery.

The three common peach pests, the peach borer, *Sanninoidea exitiosa* Say, plum curculio, *Conotrachelus nenuphar* Hbst., and shot-hole borer, *Scolytus rugulosus* Ratz. are common. The wooly aphis, *Schizoneura lanigera* Hausm., was very abundant in a few localities in northern Louisiana the past year and the apple-tree tent-caterpillar, *Malacosoma americana* Fab. is lightly distributed over the state.

In August of this year, a serious outbreak of the social grape-caterpillar, *Harrisina americana* Guer., was reported from New Orleans. In one instance this insect had completely defoliated a large number of scuppernong grape vines and was beginning to attack the cultivated grapes on the place.

Citrus Fruit Insects

The principal scale insects attacking citrus plants are the chaff scale, *Parlatoria pergandii* Comst., purple scale, *Lepidosaphes beckii* Newm., long scale, *Lepidosaphes gloveri* Pack., and the circular scale, *Chrysomphalus ficus* Ashm. The latter is also quite abundant on palms. The white fly, *Aleyrodes citri* R. & H., is abundant and injurious. It is common in almost all of the orange-growing parishes with the exception of Plaquemines and Cameron. The orange-dog, *Papilio thoas* Linn., is common but seldom does much damage.

Insects Injurious to Pecans

The common pecan-infesting insects of the state are the walnut caterpillar, *Datana integerrima* G. &. R., the fall webworm, *Hyphantria cunea* Dru., the pecan huskworm, *Enarmonia caryana* Fitch and the hickory twig-girdler *Oncideres cingulata* Say. *Datana integerrima* was especially injurious during 1907, reports of its damage coming in from all over the state.

Two May beetles, *Lachnosterna prunina* Lec. and *L. fusca* Froh., were reported as quite injurious to pecan trees in the northwestern part of the state in 1905. The former species was the more abundant.

Insects Injurious to Shade and Ornamental Trees

Among the Coccids injurious to this class of plants are the rose scale, *Aulacaspis rosae* Sandberg, the camellia scale, *Fiorinia fioriniae* Targ. var. *camelliae*, the two barnacle scales, *Ceroplastes cirripediformis* Comst. and *C. floridensis* Comst., the oleander scale, *Aspidiotus britannicus* Newst., the magnolia Lecanium, *Neolecanium cornuparvum* Thro, the gloomy scale, *Chrysomphalus tenebricosus* Comst. on Camperdown elm, the obscure scale, *C. obscurus* Comst. on oak, the oak-kermes, *Kermes galliformis* Riley, on water oak, K. *pubescens* Bogue,

on swamp post-oak, and *Parlatoria proteus* Curt., on palms, ferns, laurel and sweet olive.

Insects Attacking Man and Live Stock

The yellow fever mosquito, *Stegomyia calopus* Meigen, and the malarial mosquito, *Anopheles maculipennis* Meigen, are man's chief foes in Louisiana. About 40 other mosquitoes are known to occur in the State, but these two, being proven carriers of disease, are of the most importance.

The live stock pests are numerous, chief among them being the hornfly, *Haematobia serrata* R-D., and the screw-worm fly, *Campsomyia macellaria* Fab., the southern buffalo gnat, *Simulium pecuarum* Riley, which annually kills many animals, and the horseflies and earflies, *Tabanus* spp. and *Chrysops* spp. The principal species of *Tabanus* are the green-head horsefly, *T. costalis* Wiedemann, the lined horsefly, *T. lineola* Fab., the American gadfly, *T. americanus* Foster, the black horsefly, *T. atratus* Fab., the autumn horsefly, *T. sulcifrons* Macquart, *T. quinquevittatus* Wiedemann, *T. annulatus* Say, *T. sagax* Osten-Sacken, *T. abdominalis* Fab., *T. coffeatus* Macq., *T. fulvulus* Wiedemann and *T. fuscicostus* Hine. Species of *Chrysops* are numerous, the striped earfly, *C. vittatus* Wiedemann, the brown earfly, *C. flavidus* Wiedemann, the little earfly, *C. pikei* Whitney, *C. obsoletus* Wiedemann, *C. brunneus* Hine and *C. lugens* Wiedemann being the most abundant. The species of *Tabanidæ* assume peculiar importance economically because of their apparent participation in the spread of "charbon," or anthrax.

In opening the discussion on these papers, President Morgan stated that the boll worm is a serious pest in Tennessee. In that state, soy beans are being used to build up the soil. These plants have a habit, like that of cockle burr, of fruiting at almost any time during the season. The worms attack the late pods of the soy bean and the cowpea and prevent the development of seeds. These are the only available food plants for the insect at that time of year and it is a very difficult matter to save the crop.

Mr. Headlee stated that the injury caused by this insect to corn in Kansas has increased in the last few years. In one field he counted one hundred ears and of these ninety-nine were attacked by one or more worms.

Mr. Quaintance called attention to the fact that this insect is a serious pest of cotton in some of the southern states, and referred to the work of the Bureau of Entomology in Texas in 1903 and 1904

and subsequently, the results of which are given in Bulletin No. 50 and several Farmers' Bulletins. He considered it a most difficult pest to control on corn and did not know of any practicable method, other than fall and winter plowing, to destroy the pupæ in the soil. This practice is most effective when followed by all of the farmers in a neighborhood.

Mr. Bruner said that the silo corn crop in Nebraska is often greatly injured by this insect.

Mr. Osborn stated that in Ohio the insect has caused more injury this year than usual, but that it had probably been increasing in abundance during the past few years.

Mr. Sanderson expressed the opinion that in the northern part of the country, the prevalence of this insect is governed by the temperature of the preceding winter.

Mr. Fletcher remarked that soy beans are an excellent trap crop to plant on account of their value as a fertilizer, and Mr. Bruner stated that the red-winged blackbird destroys many of these worms.

Mr. Morgan stated that the elm leaf beetle had been found for the first time in Tennessee, during the summer of 1907, at Ryersville, in the northeastern part of the state.

Mr. Sanderson asked the best remedy for the walnut Datana, as it is very bad in New Hampshire, to which Mr. J. B. Smith replied that it is common in New Jersey and is easily controlled by crushing the larvæ on the trunks of the trees. He had found that only a small per cent of the larvæ pupate and pass the winter. Both arsenate of lead and paris green had been tried as a means of destroying the larvæ.

Mr. Hooker mentioned the fact that in Massachusetts this insect often does considerable injury to the black walnut, though parasitized, at times, by Tachinid flies.

Mr. Morgan stated that in the south this insect is heavily parasitized during some seasons. During the summer of 1907 Datana larvæ caused considerable injury in Tennessee and Louisiana by attacking pecan trees.

Mr. Fletcher spoke of the milky juice of the Norway maple and suggested that this might, in a measure, prevent insect attack. He had found *Lecanium nigrofasciatum* very abundant in two localities, and it had proved very hard to control. In reply to the latter remark, Mr. Symons stated that he had used the lime and sulphur wash against this insect in Maryland and had secured good results.

Mr. J. L. Phillips stated that the maple scale, *Chrysomphalus tenebricosus*, was first observed by him in Virginia in injurious numbers on soft maples at Charlottesville, Va., in 1899. In many cases it had

killed the main part of the tops of the trees, the trunks and larger limbs only showing signs of life. Many of the trees died outright from this attack. It has been doing considerable damage since that date, mainly to trees planted in the parks and streets of the larger cities, such as Richmond, Norfolk, Roanoke, Lynchburg, Staunton, etc.

This winter a fungus growth resembling *Sphaerostilbe coccophila* has been observed quite abundant, attacking this scale insect on some of the trees in Lynchburg. The Park Commission of Lynchburg has been spraying this winter with soluble oil to control this pest. It is his opinion, however, that the infested trees should be gradually removed and replaced by some hardier and more desirable sorts,—some that are not so subject to insect attack.

Mr. J. B. Smith mentioned having found the same fungus in a section of New Jersey, where it had never been introduced artificially, and expressed the opinion that it is of little value in that State.

Mr. R. I. Smith described the manner in which he had introduced this disease into several peach orchards in Georgia. He stated that he first visited a large orchard in Komoko, Florida, in which the San José scale had been largely destroyed, presumably by this disease, which had been introduced the year previous. He found quantities of the fungus on oak trees in and near Atlanta, Georgia, and introduced it into several orchards in the middle and southern parts of the State. This was accomplished by taking pieces of oak bark, which were infested with *Aspidiotus obscurus,* the latter being infected by *Sphaerostilbe coccophila,* and attaching this bark to peach trees infested with the San José scale. From three to six pieces were tied in each tree. This work was done during June and July, 1907, and an examination of one of the orchards in September showed that the fungus had established itself to a slight extent on the San José scale. In some cases fungus was found two or three feet from the specimen which had been tied to the limb, and in one instance it was found on an adjoining tree, upon which no fungus had been artificially introduced. Mr. Smith also mentioned finding *Sphaerostilbe* in the middle of the Hale orchard at Fort Valley, Georgia, while the nearest source of fungus on oak trees was nearly a half mile distant. He recalled finding this fungus very abundant on oak trees infested with the *obscurus* scale in the city of Atlanta, and had found maple trees in the same locality badly infested and dying from the attack of this scale, but none of the fungus was present on these trees. He believed that the work of introducing *Sphaerostilbe* into San José scale infested orchards should be given further attention and careful investigation.

Mr. Forbes gave the results of an attempt to introduce this fungus into Illinois. Artificial cultures were prepared and placed in the orchards during the spring. All of these died out during the summer. A small amount of the fungus was found under cloth bands which had been placed on the trees as tags.

Mr. Worsham gave the results of his observations on this disease in the peach orchards in Georgia, and stated that in some cases a large number of San José scales had been killed by it. He expressed the opinion that before this disease can be of any great economic importance, it will be necessary to secure a liquid substance in which the spores can be mixed, the sticking qualities of which are sufficiently great to enable the spores to adhere to the scales until conditions are favorable for development. He had mixed spores of *Aschersonia* in a gelatine solution of about thirty grams of gelatine to one gallon of water and sprayed orange trees infested with the White Fly with some success, and he thought it probable that some such method might be employed with *Sphaerostilbe*.

Mr. Quaintance called attention to the undesirability of placing too much stress on the importance of fungus diseases in insect control. These diseases are often important natural checks, but in the case of such species, for instance, as the San José scale, the prolificacy and means of spread of the species are such as to render it usually necessary to adopt artificial means of control, such as spraying. So far as he knew, the *Sphaerostilbe* disease of this insect, even in Florida, where moisture conditions are most favorable for its development, could not be relied on in place of spraying, and he thought it probable that lime and sulphur treatment of the trees for scale would greatly check or destroy the fungous disease.

Mr. J. B. Smith pointed out that the season of 1906–1907 was such that experiments with this disease failed to give valuable results. In New Jersey less scale was present in 1907 than had been the case for the past five years, but this was not due to the presence of the fungus.

Mr. Forbes considered that gelatine might be added to the culture material ordinarily used, and that this might assist the fungus in getting established in the orchard.

Mr. Burgess called attention to the effective work which had been done by the fungus disease which attacks the caterpillars of the brown-tail moth. He thought that if cultures of this disease could be applied under burlaps it might secure a good start. Large numbers of trees in the moth infested district in Massachusetts are banded with strips of burlap, and these strips, particularly in woodlands, retain a considerable amount of moisture, which would furnish good conditions for the development of the disease.

Mr. Sanderson described the recent spread of the gypsy moth in New Hampshire, and stated that small colonies, some of only a single egg cluster each, were being found in the hill towns miles from the nearest known infested point. He believed that the only way of accounting for the presence of these colonies is that there is some means of distribution of this insect which at present is unknown.

This closed the discussion of the papers presented, and the meeting formally adjourned.

We regret that owing to limitation of space it has been impossible to include in this number all of the papers presented by title or otherwise, at the twentieth meeting of the Association of Economic Entomologists. The papers remaining will appear in the next issue.

STATEMENT BY THE STANDING COMMITTEE ON PROPRIETARY INSECTICIDES

At the Chicago meeting it was voted (see page 10, Feb. issue,) that all new proprietary insecticides offered to members of this association be referred to this committee, who will then proceed as suggested in the report of the committee on this matter of last year, Part II.

Your committee has recently received communications from J. W. Lafer, Catawba Island, Ohio, regarding a remedy to be applied to the roots of trees to prevent the attacks of insects and generally stimulate the tree. Mr. Lafer states that some 12 Stations have signified their willingness to test this remedy. Your committee begs to recommend to the entomologists of the association that any tests which may be desired be made after consulting with this committee, so that the number of tests may be reduced in number. It is the judgment of your committee that the testing of this substance is of doubtful expediency until the proportions of its ingredients are known.

Your committee further requests that any new insecticides which are submitted for testing be called to their attention with a statement as to whether the party wishes to make a test of them and any suggestions concerning the matter. We believe that in this way the testing of proprietary insecticides can be much simplified.

As instructed at Chicago, your committee has had prepared, thru the courtesy of the Bureau of Chemistry of the Department of Agriculture, a National Insecticide Law which will probably be introduced during the present session of Congress. Copies will be furnished members of the association as soon as the bill is in print.

E. DWIGHT SANDERSON,
Chairman.

THE PEACH SAWFLY: A CORRECTION.

By B. H. Walden, *Agricultural Experiment Station, New Haven, Conn.*

Following the article, *Notes on a New Sawfly Attacking Peach,* in Bulletin 67 of the Bureau of Entomology, page 87, is a note regarding the occurrence of this insect in New Jersey and Pennsylvania. These records do not apply to the peach sawfly, but to the maple stem-borer, *Priophorus acericaulis* MacG., and were given in a discussion following an account of the latter insect by Dr. Britton (see page 94).

The peach sawfly, *Pamphilius persicum* MacG., promises to become quite a serious pest in Connecticut peach orchards. The owners of the orchard in Yalesville where the insect was first found, sprayed over four thousand peach trees during the past season with arsenate of lead and water, using three pounds in fifty gallons. The larvæ were readily killed and the foliage was not injured by the spray. The sawfly has been found in several places in New Haven county and at a distance of about fifteen miles from where it was first discovered. We have received no record of its occuring outside of the State.

An account of the past season's observations regarding the insect has been published in the seventh annual report of the State Entomologist of Connecticut, p. 285.

NOTES ON PSYLLOBORA 20-MACULATA SAY.

By John J. Davis, *Urbana, Ill.*

In bulletin vol. 1, no. 1 (technical series) of the Ohio Agricultural Experiment Station, Mr. C. M. Weed writes of having found the larvæ of *Psyllobora 20-maculata* on false or blue lettuce, iron-weed, and various kinds of false sunflower, and as these plants were infested with plant lice, he indicates that they may feed upon them, although no observations to that effect were made.

June 23, 1906, I found the larvæ and one pupa of this Coccinellid on the foliage of the common wild phlox (*Phlox divaricata*) at Homer, Ill. None of these plants were infested with plant-lice and these larvæ were observed feeding upon the epidermal tissues of the leaves.

Mr. Weed gave the length of the pupal life as being about a fortnight, while in my records I found the pupal period to be six days. Mr. Weed's observations were made in the fall and mine were made in the spring. These differences in the lengths of the pupal period may be accounted for by reason of the difference of the effective temperatures in the spring and fall, development being more rapid in the latter than in the former, even though the temperatures may be the same.

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APRIL, 1908

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Reprints of contributions may be obtained at cost. Minor line figures will be reproduced without charge, but the engraving of larger illustrations must be borne by contributors or the electrotypes supplied. The receipt of all papers will be acknowledged.—EDS.

Success is gratifying, and it is a pleasure to announce that our subscription list has already exceeded what most of the editors dared to expect at the outset. Furthermore, the amount of advertising has surpassed our expectations. The financial condition of the JOURNAL is such as to give every reasonable assurance of continued stability. Special thanks for this are due Prof. Wilmon Newell, State Entomologist of Lousiana, who, at the request of the business manager, kindly took upon his shoulders the onerous duties of advertising manager. This and the preceding number bear witness to the value of his services. The advertising privileges of this JOURNAL are open only to responsible parties. The editors cannot undertake to guarantee their reliability, though they have endeavored to exclude all advertisements of apparatus and material of questionable value. It should be remembered that the purpose of advertising is to bring more or less unknown materials to the attention of the public, and the appearance of an advertisement in this JOURNAL must not be construed as an endorsement of the claims made by the advertiser.

This number nearly completes the proceedings of the last meeting of the Association of the Economic Entomologists. We rely upon economic entomologists throughout the country to supply matter for the remaining four numbers, and judging from present indications, there will be no scarcity of first-class material. We trust that all interested in the success of the JOURNAL will bear its needs in mind and use its columns to the best possible advantage. Men contemplating an extended investigation might well announce the same in these columns and thus secure valuable suggestions, and possibly extensive help, from those pursuing similar lines of work in other parts of the country. Coöperation, while it involves some minor sacrifices, offers great advantages to those who avail themselves of its opportunities. The

discussion of methods of work is an exceedingly fruitful line of effort, and it is a pleasure to give in this number a summarized account of the note system which has proved of such great service in the extended investigations upon the boll weevil. No one system is perfect, and undoubtedly there are a number of our readers who have some methods of work which would prove of great service to others if they were only made known.

A rather pessimistic article on the future of Economic Entomology, from the pen of H. T. Fernald, appeared in *Popular Science Monthly* for February, 1908. There is much to be commended in this summary, though we prefer to take a somewhat optimistic view of the situation. While it is true that many farmers in certain sections of the country disregard the recommendations of the economic entomologists, the situation is by no means so discouraging as some would have us believe. This condition is bound to right itself in the near future, since it is only a question of economics. As soon as the agriculturist can see a substantial gain by the adoption of improved methods for controlling insect pests, a sweeping change will result. Such has come about in a number of the more progressive fruit growing sections of New York, and there is a marked tendency toward the adoption of better methods for the control of insects in other portions of the state. The prejudice against the use of insecticides and the disinclination toward the preparation of apparently complex mixtures of insecticides and fungicides is rapidly disappearing, since the less aggressive learn readily from their progressive neighbors. We are far from being discouraged at the outlook. It seems to us distinctly much more promising than ever before. The remarkable progress made in the last decade is an earnest of what may be expected in the near future. It is only necessary to mention such pests as mosquitoes, tsetse flies and cattle ticks to call to mind how the impossible of yesterday has become the thoroughly practical of today. It is true that such destructive leaf feeders as the gypsy moth in Massachusetts and the boll weevil in the South are still serious enemies of the agriculturist. The aim of the economic entomologists is control rather than extermination, and the fund of valuable information respecting both of these species shows beyond question the possibility of controlling them and demonstrates its practicability under most conditions. Furthermore, the outlook is most encouraging in that the fundamentals underlying the control of insect pests are being studied as never before. The work with the parasites of the gypsy and brown-tail moths has been conducted on a hitherto undreamed scale. The investigations of the parasites of the boll weevil not only show the species which prey upon this pest but

W. G. Johnson

go farther and ascertain their origin and demonstrate the possibility of rearing parasites in native innoxious weevils and practically compelling them to leave the original host and attack this destructive pest.

The present indications are that great advances will be made in the near future. Most of this progress will result from the application or extension of previously recognized truths, rather than from the exploitation of entirely new methods. That there is great need of close investigations of the ecology of injurious species is evidenced by recent advances made possible thereby. We are strongly of the opinion that investigations of entire groups are to occupy a prominent place in the future, because this is one of the best ways of ascertaining every fact which may be of service in controlling an injurious pest. The application of methods found of value in other sciences will doubtless take a prominent place in the economic entomology of the near future. We much prefer to dwell in the New Testament atmosphere with its promises of the disclosure of truth to all, rather than to exist under Old Testament conditions, with its revelations to the few. We are of the opinion that the discoveries of truth are limited only by the opportunity and the visual (mental as well as optical) powers of the observer. We admire Moses, and while leaders are valuable, is it not true that our working entomologists constitute a small army of leaders, all contributing to the attainment of a common goal—the pushing back of the borders of the unknown.

Obituary

WILLIS GRANT JOHNSON

Prof. Willis G. Johnson, associate editor of the *American Agriculturist,* member of the board of control of the New York Agricultural Experiment Station, and until the last few years prominent in entomological investigations, died at his home in New York City, March 11, 1908. He was stricken with slow spinal meningitis and passed away while in the prime of life.

Professor Johnson was born July 4, 1866, at New Albany, Ohio, and received his preparatory education in the Ohio State University from 1884–1887. He was graduated from Cornell University in 1892, with the degree of A. B., receiving A. M. in 1894. He was a post-graduate student in science and instructor at the Leland Stanford, Jr., University from 1892 to 1894. Then he was appointed instructor in the University of Illinois, and was engaged in special agricultural in-

vestigations, preparing at this time his extensive account[1] of the Mediterranean Flour Moth. He was appointed state entomologist of Maryland in 1896, organizing the state horticultural department, of which he became chief. He was also at this time professor of invertebrate zoölogy and entomology in the Maryland Agricultural College, and entomologist to the Agricultural Experiment Station. He organized the State Horticultural Society and at the time he severed his connection with the state was elected a life member, a unique honor. His best work in economic entomology was done in Maryland. He took a leading part in the enactment and enforcement of the law against San José scale, and was the author of several important publications on this pest. Continuing his work upon the Mediterranean flour moth and upon the San José scale, he developed the possibilities of fumigating with hydrocyanic acid gas, particularly in its relation to the control of grain pests in mills. His book entitled "Fumigation Methods," 1902, was the outcome of this work. He continued to write articles on economic entomology for several years after his connection with the *American Agriculturist*, and was also author of several works on other than entomological subjects. He resigned his position as state entomologist of Maryland in 1900 and became associate editor of the *American Agriculturist*, a position which he held to the time of his death. Professor Johnson was an exceedingly active man, being a member of a number of scientific associations, such as the American Association of Agricultural Colleges and Experiment Stations, Society for the Promotion of Agricultural Science, American Pomological Society and the Association of Economic Entomologists. He was appointed in July, 1907, a member of the board of control of the New York State Experiment Station, and had been for several years a director of the American Institute of New York City. He is survived by his wife, a son and a daughter. His mother and several brothers reside at Columbus, Ohio. Interment was at Lake View, Ithaca, N. Y.

The multifarious duties of an editorship prevented his giving much attention to entomology in recent years, though he maintained to the last a keen interest in this branch of work. In the death of Professor Johnson, economic entomology has lost an enthusiastic, aggressive champion, and the sad news has caused profound sorrow among entomologists throughout the country.

E. P. F.
A. F. B.

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[1]1896, 19th report of the State Entomologist of Illinois, Appendix, p. 1–66.

CHARLES ABBOTT DAVIS

Mr. Charles Abbott Davis, curator of the Roger Williams Park museum at Providence, R. I., died at the Rhode Island hospital January 28, 1908, from cerebro spinal meningitis.

He was a devoted student of natural history and was particularly interested in entomology and shells. He was a member of many societies, among which were the Entomological Society of America, Aggassiz Association and the Rhode Island Field Naturalists' Society, having organized the latter.

A. F. B.

Reviews

Studies of Parasites of the Cotton Boll Weevil, by W. Dwight Pierce, U. S. Department of Agriculture, Bureau of Entomology, Bulletin 73.

Theoretically at least, the best method of controlling an injurious insect is by encouraging its natural enemies. All economic entomologists recognize the value of parasites and predaceous forms as checks upon the multiplication of insect pests, and many have made more or less general recommendations with a view of obtaining the greatest possible assistance from these agencies. Careful studies have been made of the parasites of several of our more important insect enemies such, for example, as the exhaustive study by Dr. Howard, of the parasites of the white marked tussock moth, and a careful investigation by Fiske, of the parasites of the common tent caterpillar. The parasites of the Coccidae, thanks again to the work of Dr. Howard, are relatively well known, and enemies of this group have been successfully introduced into localities and very satisfactorily controlled dangerous outbreaks of their hosts. The bulletin under consideration is specially noteworthy, in that it gives a large amount of accurate data relating to the parasites of an entire group in a faunal area. The investigator has ascertained the sources from whence come the parasites attacking the boll weevil. A study of the biology of the native host forms has shown the possibility of taking advantage of natural conditions within certain limitations so as to force insects, normally subsisting on species of small or no economic importance, to attack one of our most dangerous pests. Such methods can be employed to advantage only after the factors controlling the existence of these forms are thoroughly understood. These studies are a striking illustration of the importance of thorough investigations of an entire group. The author is to be congratulated upon having produced a very valuable and suggestive contribution to economic entomology. E. P. F.

Report of the Entomological Department of the New Jersey Agricultural College Experiment Station for 1907, by John B. Smith, pages 389–560.

This publication appears in its usual form, and like its predecessors contains numerous valuable observations upon the more injurious species of the

year, special studies being made upon root maggots. In reporting upon field tests of insecticides for controlling San José scale, Dr. Smith states that lime-sulphur washes have not gained in favor in New Jersey, though they have fully held their own. He reports good results as being almost invariably obtained when a miscible oil, such as scalecide, is used, and devotes considerable space to the discussion of home made miscible oils. The somewhat extended evidence respecting the application of bands of carbolic acid to trunks of trees is by no means favorable to this method of treatment. Brief notes are given on some new materials which may possibly be used as insecticides; namely, arsenate of iron, arsenate of lime and arsenate of barium.

About half of the report is deservedly occupied by an account of the exceedingly important work against mosquitoes done in 1907. Details are given respecting methods and the amount of work accomplished in different localities. We regret that the author has not seen fit to incorporate in this portion of the report a summarized statement as to what has already been accomplished along this most practical line of effort, so that one can, in a short time, gain an adequate idea of the progress made in freeing New Jersey from the blood-thirsty swarms of mosquitoes. One of the most interesting occurrences of the year was the discovery of the larva and breeding habits of *Culex perturbans*, a species which up to last year had eluded the vigilance of all Americans working upon the biology of this group.

E. P. F.

Report on the Injurious Insects and Other Animals Observed in the Midland Counties during 1907, by Walter E. Collinge, 58 pages.

This report gives summarized accounts of a large number of the more important injurious insects, together with reports on insecticides and fungicides. Experiments in controlling the gall mite on black currant, *Eriophyes ribis*, show that spraying with the lime-sulphur wash is most effective. Reporting upon a series of experiments for destroying all insects and other injurious organisms inhabiting the soil, Prof. Collinge states that he has obtained a fumigant designated as "Apterite" which will effectually rid the soil of these enemies. This is presumably a proprietary material, as no clue is given respecting its composition. The general appearance of this report is exceedingly good, the letter press and paper being much above the average.

E. P. F.

Current Notes

Conducted by the Associate Editor

The Associate Editor will be engaged during the summer in work on predaceous beetles which are being imported to assist in controlling the gypsy moth. After May 1st all communications should be directed to *Melrose Highlands, Mass., Care Gypsy Moth Parasite Laboratory,* instead of to Washington, D. C.

Graduate School of Agriculture. The preliminary announcement of the

third session to be held July 6th to the 31st, 1908, at Cornell University, Ithaca, N. Y., and at the New York Agricultural Experiment Station, Geneva, N. Y., gives the following list of entomologists on its faculty:

Dr. L. O. Howard, chief, U. S. Bureau of Entomology; Prof. S. A. Forbes, professor of zöology, University of Illinois; Prof. M. V. Slingerland, assistant professor of economic entomology, Cornell University; P. J. Parrott, entomologist, New York Agricultural Experiment Station; Dr. James G. Needham, assistant professor of limnology, Cornell University; Dr. A. D. MacGillivray, assistant professor of entomology, Cornell University; Dr. W. A. Riley, assistant professor of entomology, Cornell University; Prof. E. Dwight Sanderson, director and entomologist, New Hampshire Agricultural Experiment Station; Dr. E. P. Felt, state entomologist of New York.

A provisional program will appear shortly. The JOURNAL hopes to publish all the best papers given in the course on entomology.

The Louisiana Naturalists Society held its first meeting of the year Saturday, Feb. 1st, at the State Museum at New Orleans. There was a very large attendance and several important papers were read and discussed. Mr. J. B. Garrett of the Louisiana State Experiment Station read a carefully prepared paper on the "pou-a-pouche" (*Pseudococcus calceolariae*) which is a source of injury to the sugar cane. Mr. Blouin outlined the experience of the Audubon Park Experiment Station with the same insect. Mr. E. Foster read a short paper on some forms of Entomostraca occurring in New Orleans. Mr. Foster has for years been making a special study of these organisms in which the waters in the vicinity of New Orleans are particularly rich. Mr. J. C. Smith, who is well known as an authority on Protozoa, gave a short talk on a species of algae which had been most disagreeably abundant in Lake Pontchartrain a few months back. Mr. R. S. Cocks exhibited photographs of what may prove to be a new species of honey locust, *Gleditschia*, discovered near Shreveport. The society then adjourned. This society has met continually since 1897, it consists of about 60 members residing in different parts of the state and has for its object the study of all departments of natural history. The present officers are: President, Prof. B. H. Guilbeau, Secretary, R. S. Cocks, Treasurer, Mr. G. R. Westfeldt.

We have been recently advised that Prof. J. L. Phillips, State Entomologist of Virginia, is in need of an assistant in the orchard and nursery inspection work of his office.

Mr. H. E. Hodgkiss has resigned his position as Assistant to the State Entomologist of Illinois and returned to his former position at the New York Agricultural Experiment Station. Address, Geneva, N. Y.

Prof. Walter E. Collinge, head of the Department of Economic Zoölogy in the University of Birmingham, and Editor of the "Journal of Economic Biology," has accepted the responsible position of Director of the Cooper Research Laboratory at Berkhamsted, England.

Appointments in the Bureau of Entomology, Washington, D. C.:

Mr. G. E. Merrill of New Hampshire has been appointed as a special field agent and will take charge of demonstration work in orchard spraying in Nebraska.

Mr. C. B. Hardensberg, a graduate of the University of Wisconsin, and a graduate student at the University of Pennsylvania, has been appointed special field agent and will be engaged in the investigation of insects affecting cranberries in Wisconsin during the season.

Mr. Victor S. Barber of California has been appointed special field agent and will be engaged in investigation and demonstration work for controlling forest insects.

Prof. Trevor Kincaid, Professor of Zoölogy at the University of Washington, Seattle, Wash., has been selected by Dr. Howard to collect parasites of the gypsy moth in Japan. He sailed for that country March third. The work is being undertaken by the Bureau of Entomology in coöperation with the State of Massachusetts. Shipments of parasites from Japan that have been received in the past have arrived in unsatisfactory condition and it is desired to employ every means possible to secure and utilize any of their beneficial insects. Prof. Kincaid was selected on account of his experience as a collector, having been a member of the Harriman Expedition which made extensive collections in Alaska several years ago. His location on the Pacific coast also made him particularly available for the work. Previous to his sailing, the Japanese entomologists were notified by Dr. Howard and much assistance will be secured from them in obtaining parasitized material.

Mr. C. H. T. Townsend of the Bureau of Entomology has been transferred from Washington to the gypsy moth laboratory at Melrose Highlands, Mass., where he will have charge of breeding and rearing the imported Dipterous parasites of the gypsy and brown-tail moths.

The Committee on Agriculture of the house of representatives of the 60th Congress has reported the following appropriations for the Bureau of Entomology:

For the Bureau of Entomology	$184,960
For prevention of the spread of gypsy and brown-tail moths	250,000

The committee also recommends an appropriation for the Bureau of Animal Industry of $250,000 for eradicating the cattle tick.

Mr. C. H. Popenoe of the Bureau of Entomology is investigating truck crop insects at Norfolk, Virginia. Particular attention is being given to a study of the pests affecting spinach and strawberries.

Volume 9 of the Proceedings of the Entomological Society of Washington for the year 1907 will be issued during the present month. The numbers will be published quarterly hereafter.

Mailed April 15, 1908.